

```
In [1]: from AtmoBuilder import AtmoBuilder  
  
import numpy as np  
import matplotlib.pyplot as plt  
import copy  
  
%matplotlib inline
```

```
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 988 MS stars from /Users/joachim/lsst/DarwinX86/sims_sed_library/2014.1  
0.06/starSED/kurucz/  
# Read 849 white dwarfs from /Users/joachim/lsst/DarwinX86/sims_sed_library/20  
14.10.06/starSED/wDs/  
# Read 74 mlt stars from /Users/joachim/lsst/DarwinX86/sims_sed_library/2014.1  
0.06/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, d  
eltaGreyRange=[-20.0,20.0], err=5.0, componentBins=50, deltaGreyBins=51, regr  
essionSed='mss'):  
  
    prange, pnum = ab._componentCheck(comp,20)  
  
    atmo_std = ab.buildAtmo(ab.parameters, airmass)  
  
    name_max = 'max_dGTest_OR' + str(int(maxp*100.0))  
    name_min = 'min_dGTest_OR' + str(int(minp*100.0))  
  
    ab.computeDeltaGreyFit(comp, deltaGrey, atmo_std, deltaGreyRange=deltaGre  
yRange, componentBins=componentBins,  
                           deltaGreyBins=deltaGreyBins, regressionSed=regress  
ionSed, pickleString=name_max, plotDmags=False, override=True, overrideValu  
e=maxp)  
    ab.computeDeltaGreyFit(comp, deltaGrey, atmo_std, deltaGreyRange=deltaGre  
yRange, componentBins=componentBins,  
                           deltaGreyBins=deltaGreyBins, regressionSed=regress  
ionSed, pickleString=name_min, plotDmags=False, override=True, overrideValu  
e=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: 988 Kurucz MS 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_H20_dG_XSTD12_DGR-2020_E5_mss_u_51dgb_50b_max_dGTest_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_H20_dG_XSTD12_DGR-2020_E5_mss_g_51dgb_50b_max_dGTest_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_H20_dG_XSTD12_DGR-2020_E5_mss_r_51dgb_50b_max_dGTest_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_H20_dG_XSTD12_DGR-2020_E5_mss_i_51dgb_50b_max_dGTest_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_H20_dG_XSTD12_DGR-2020_E5_mss_z_51dgb_50b_max_dGTest_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_H20_dG_XSTD12_DGR-2020_E5_mss_y4_51dgb_50b_max_dGTest_OR120.pkl'  
Saved LogL at best fit deltaGrey for y4 filter.  
  
AtmoBuilder.py:893: FutureWarning: comparison to `None` will result in an elementwise object comparison in the future.  
    if sedkeylist == None:  
        /Users/joachim/lsst/DarwinX86/anaconda/2.2.0/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):
```

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 1.55579508632e-06 3.11159017264e-06  
g 0.98 12.00 1.24334170041e-06 2.48668340083e-06  
r 0.98 12.00 6.27764288607e-06 1.25552857721e-05  
i 0.98 12.00 3.79293031604e-06 7.58586063209e-06  
z 0.98 12.00 0.00125138236749 0.00250276473498  
y4 0.98 12.00 0.0238474357411 0.0476948714822

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: 988 Kurucz MS 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\_H20\_dG\_XSTD12\_DGR-2020\_E5\_mss\_u\_51dgb\_50b\_min\_dGTest\_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\_H20\_dG\_XSTD12\_DGR-2020\_E5\_mss\_g\_51dgb\_50b\_min\_dGTest\_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\_H20\_dG\_XSTD12\_DGR-2020\_E5\_mss\_r\_51dgb\_50b\_min\_dGTest\_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\_H20\_dG\_XSTD12\_DGR-2020\_E5\_mss\_i\_51dgb\_50b\_min\_dGTest\_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\_H20\_dG\_XSTD12\_DGR-2020\_E5\_mss\_z\_51dgb\_50b\_min\_dGTest\_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\_H20\_dG\_XSTD12\_DGR-2020\_E5\_mss\_y4\_51dgb\_50b\_min\_dGTest\_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 1.55579508632e-06 3.11159017264e-06  
g 0.98 12.00 1.24334170041e-06 2.48668340083e-06

```

r 0.98 12.00 6.27764288607e-06 1.25552857721e-05
i 0.98 12.00 3.79293031604e-06 7.58586063209e-06
z 0.98 12.00 0.00125138236749 0.00250276473498
y4 0.98 12.00 0.0238474357411 0.0476948714822

```

```

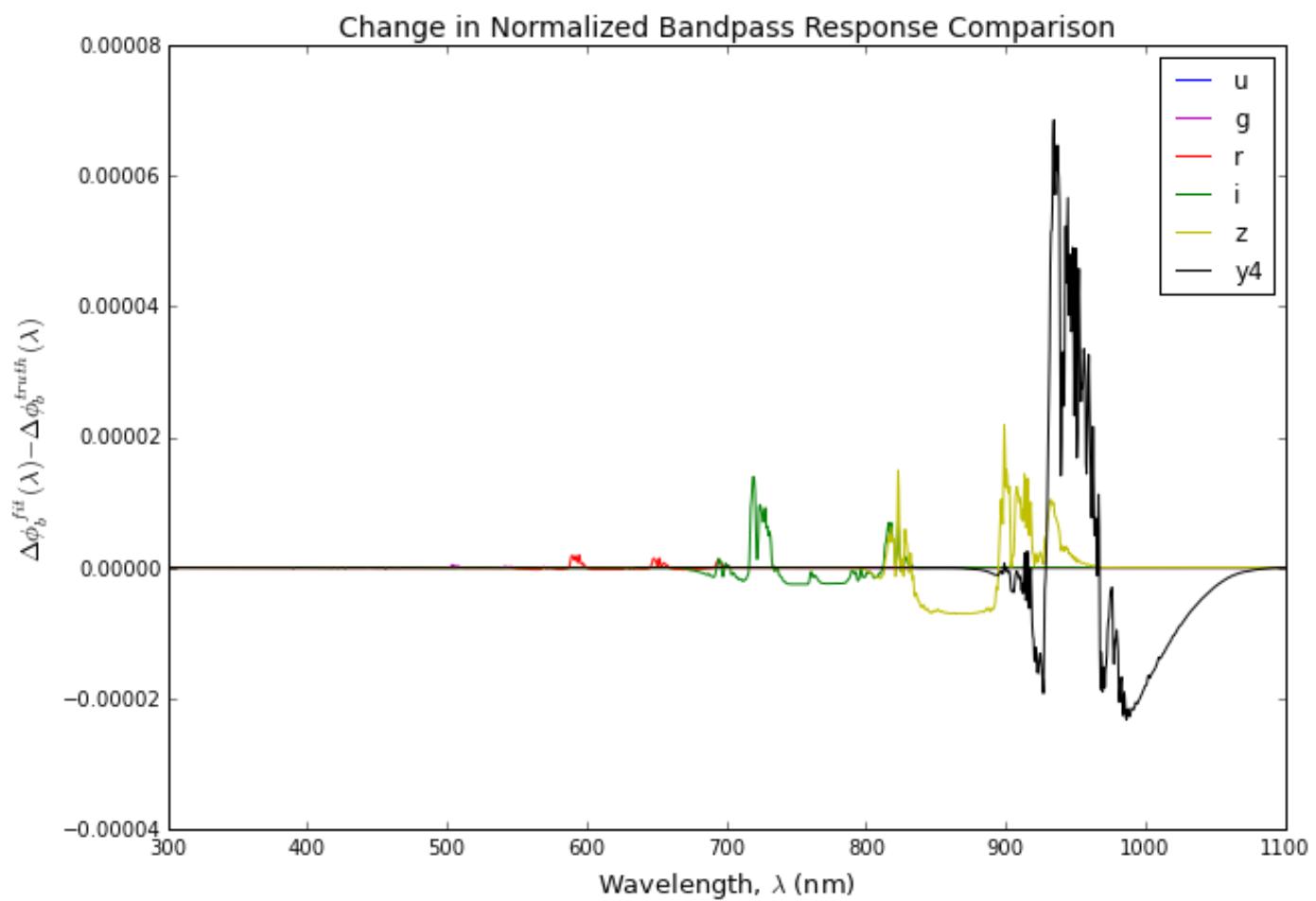
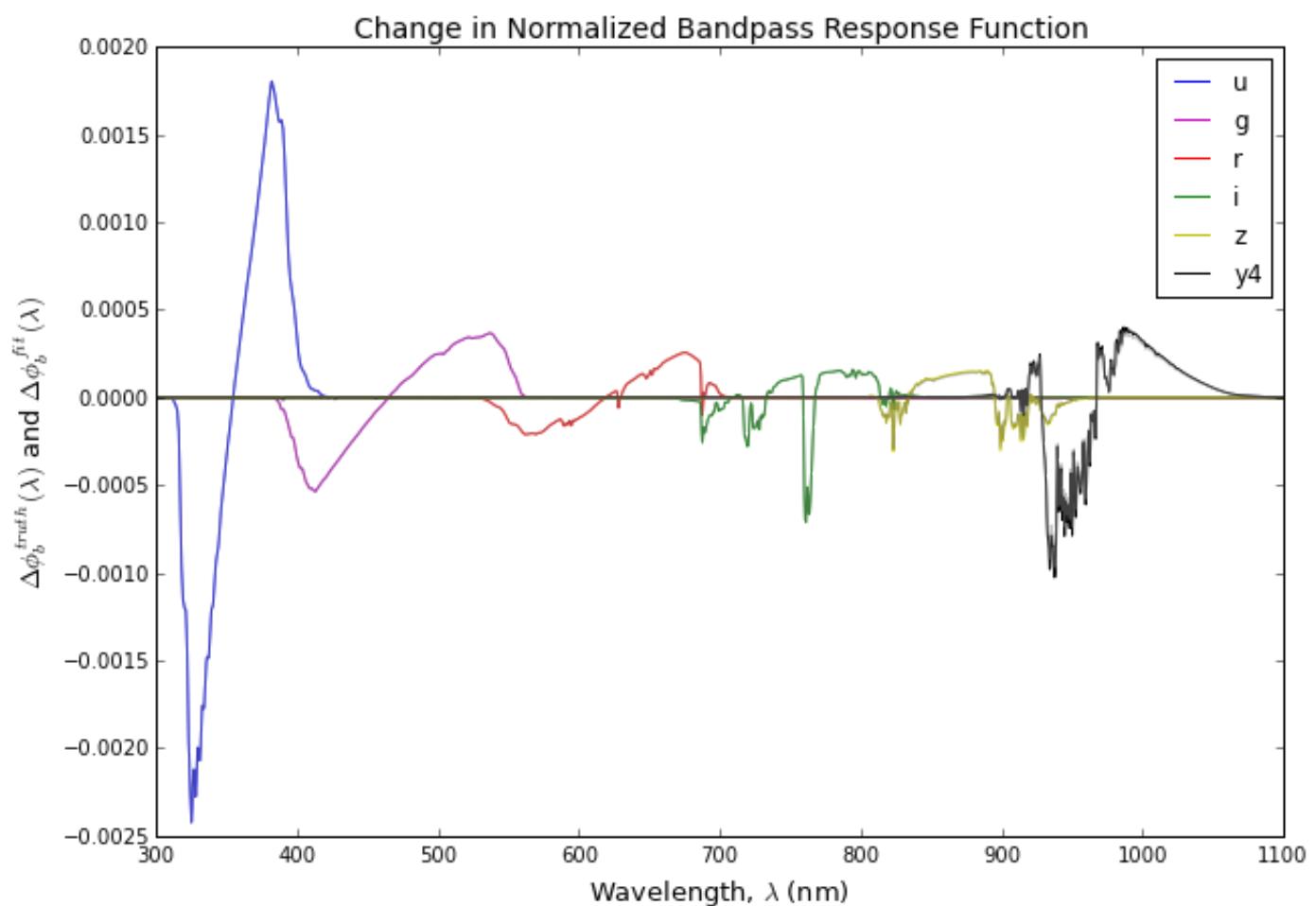
Override best fit parameters (Filter, H2O, dG):
u 0.80 12.00
g 0.80 12.00
r 0.80 12.00
i 0.80 12.00
z 0.80 12.00
y4 0.80 12.00

```

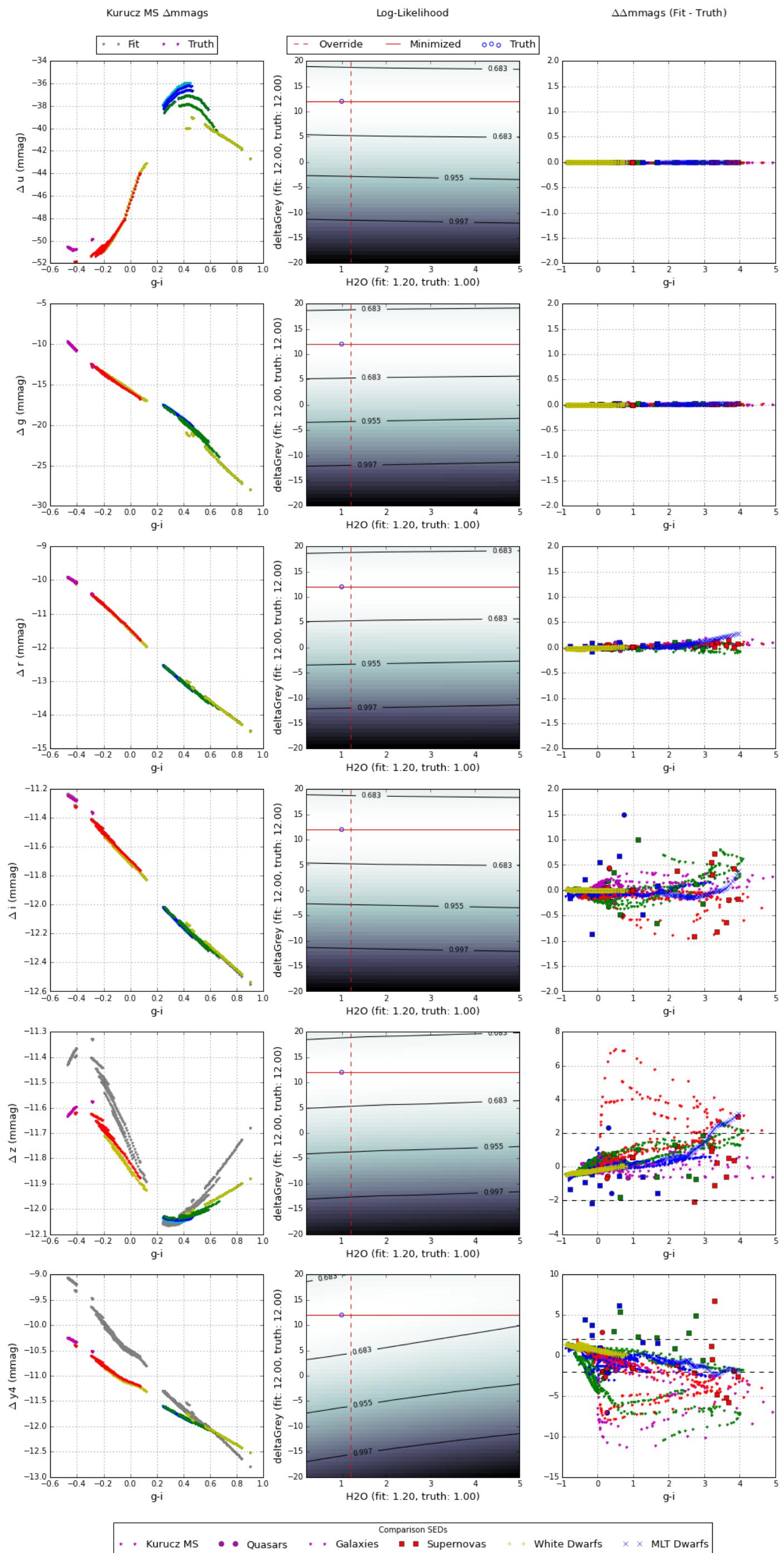
```

/Users/joachim/lsst/DarwinX86/anaconda/2.2.0/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':

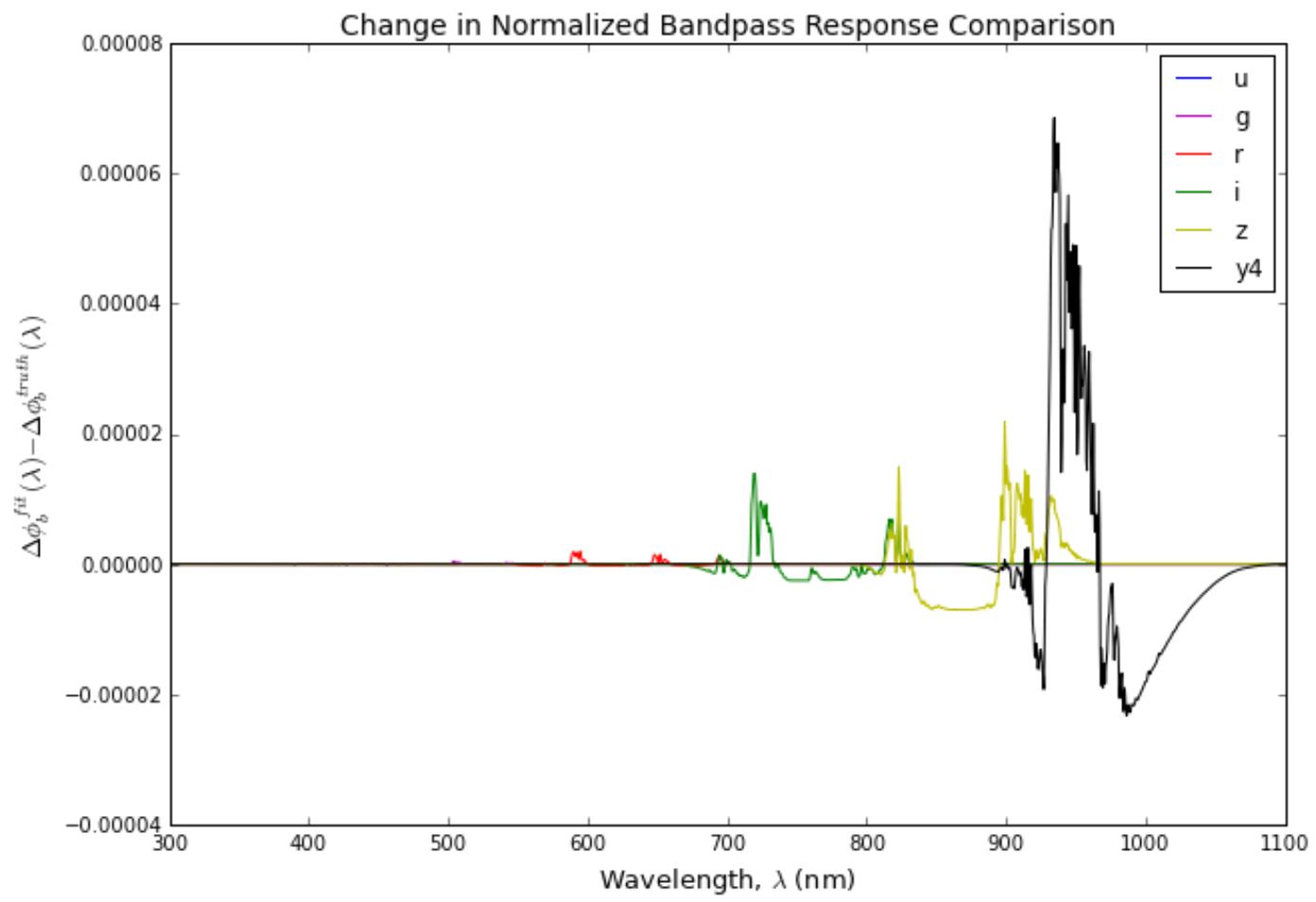
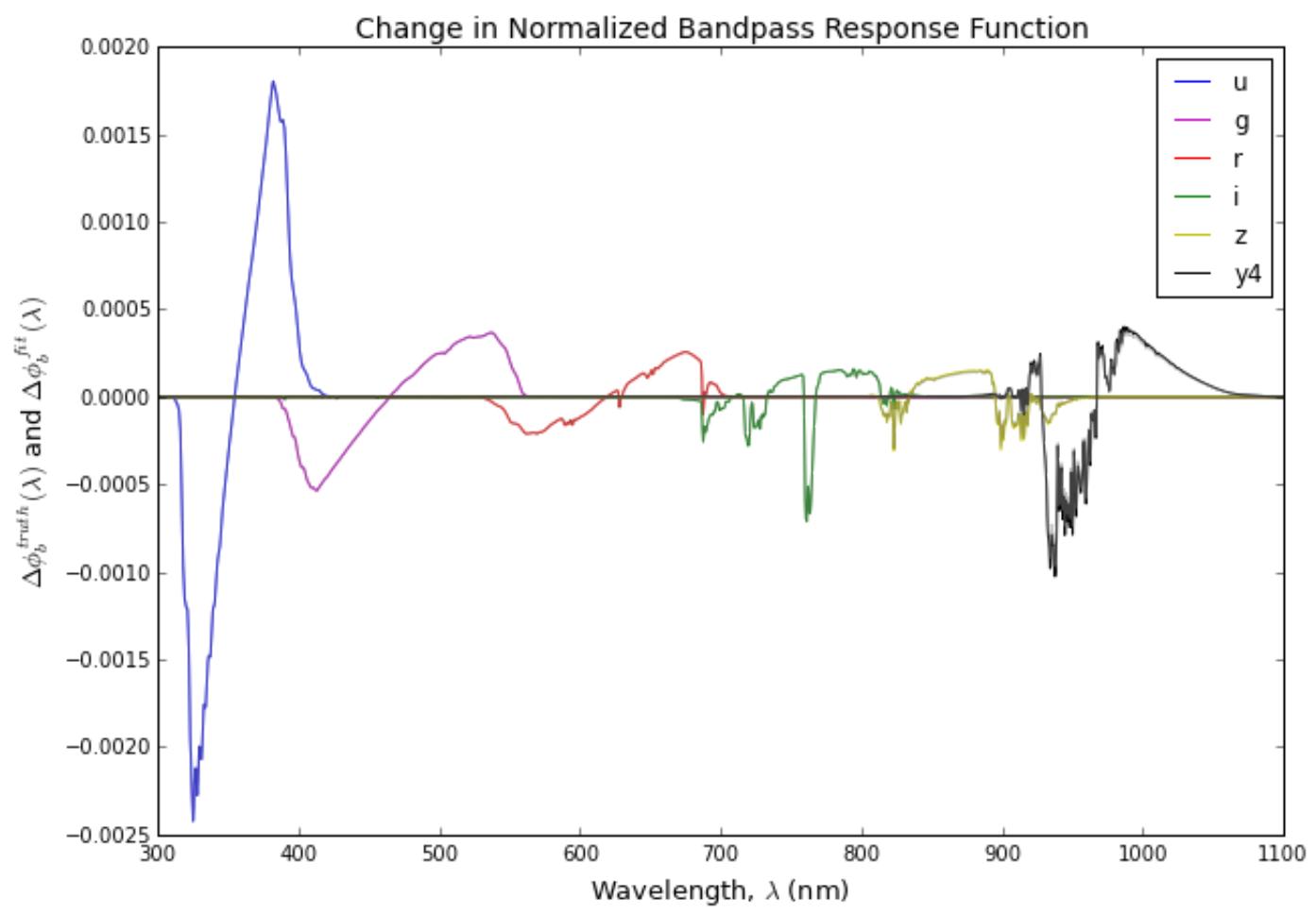
```



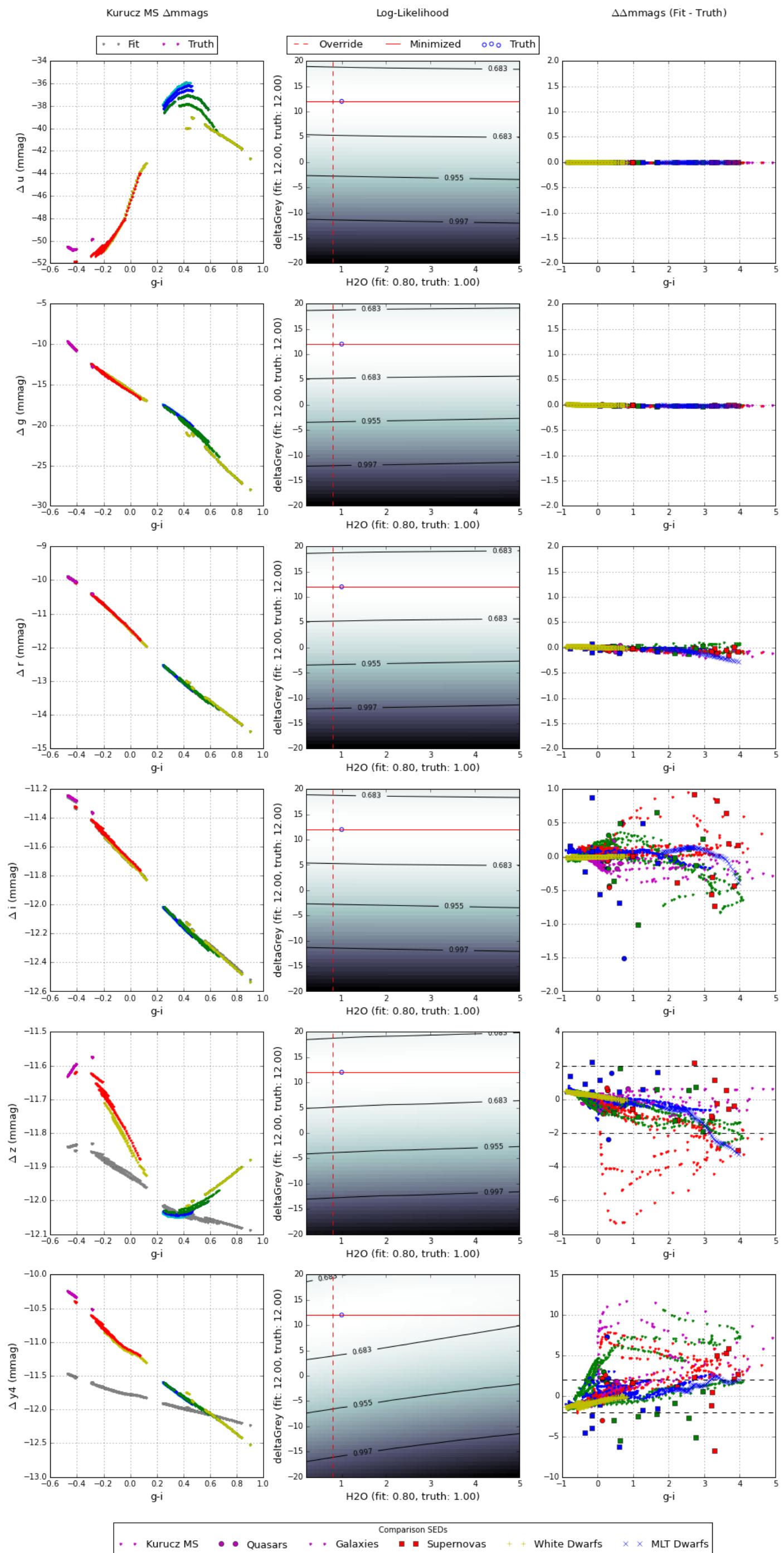
$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey}: 12.0$ )



Comparison SEDs



$\Delta\text{mmags}$ , 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: 988 Kurucz MS 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_H20_dG_XSTD12_DGR-2020_E5_mss_u_50dgb_50b_max_dGTest_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_H20_dG_XSTD12_DGR-2020_E5_mss_g_50dgb_50b_max_dGTest_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_H20_dG_XSTD12_DGR-2020_E5_mss_r_50dgb_50b_max_dGTest_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_H20_dG_XSTD12_DGR-2020_E5_mss_i_50dgb_50b_max_dGTest_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_H20_dG_XSTD12_DGR-2020_E5_mss_z_50dgb_50b_max_dGTest_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_H20_dG_XSTD12_DGR-2020_E5_mss_y4_50dgb_50b_max_dGTest_OR120.pkl'
Saved LogL at best fit deltaGrey for y4 filter.
Saved Chi-Squared at best fit deltaGrey for y4 filter.
Completed y4 filter.

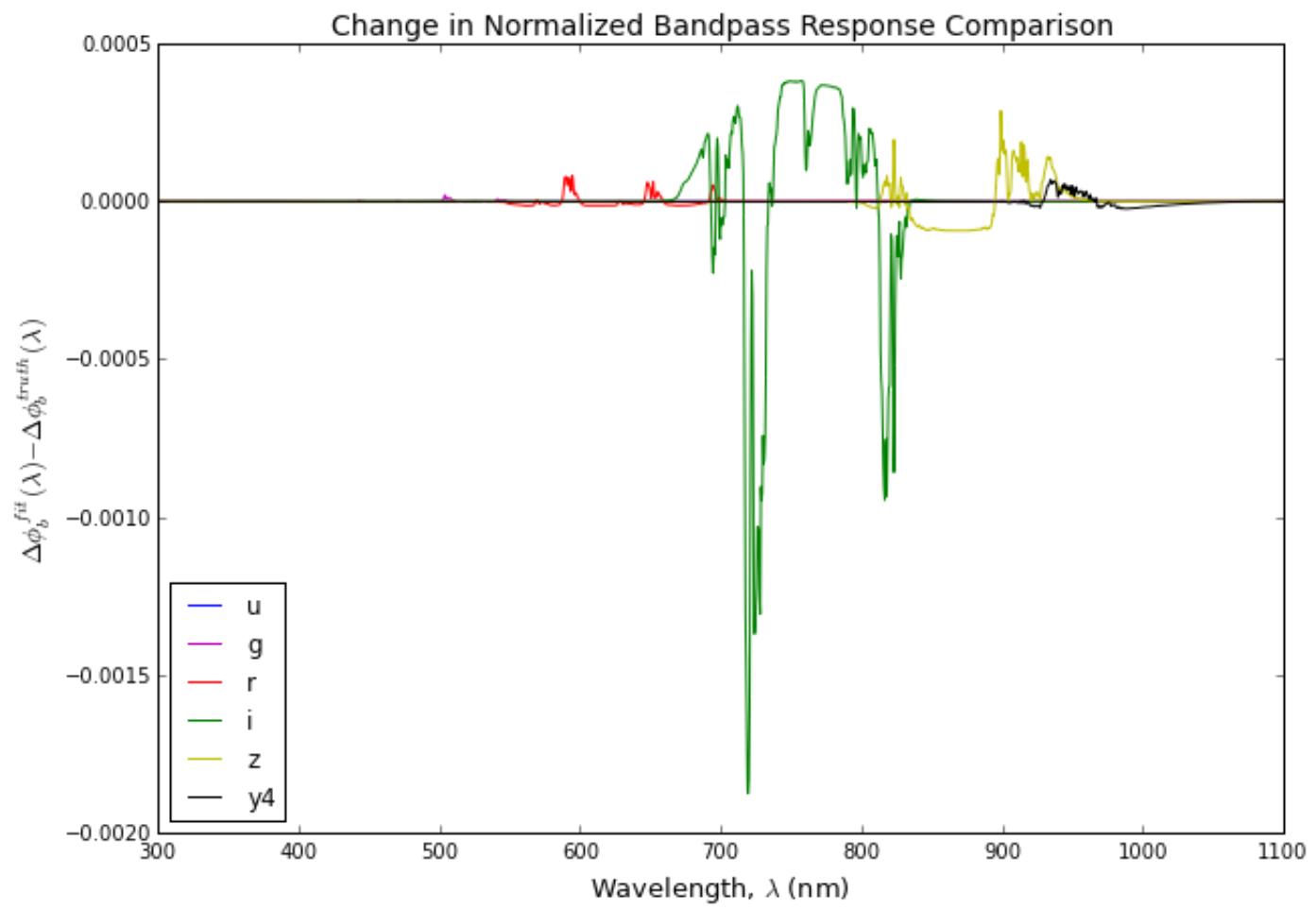
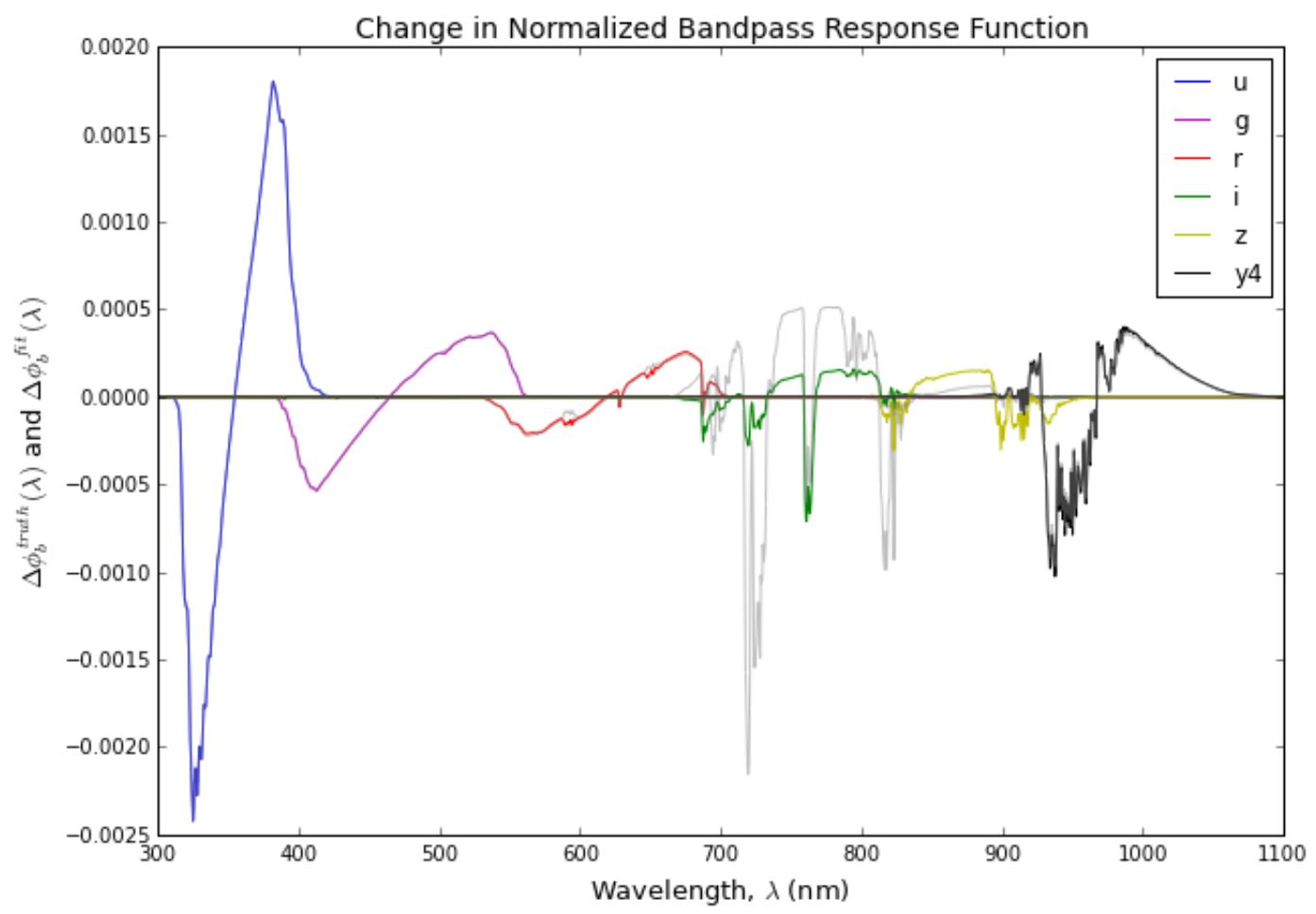
Best fit parameters (Filter, H2O, dG, logL, Chi-Squared):
u 5.00 11.84 0.272644406703 0.545288813406
g 0.20 11.84 0.489582382077 0.979164764153
r 0.30 11.84 0.516304757066 1.03260951413
i 3.53 11.84 0.404493280882 0.808986561765
z 0.79 11.84 0.256843264397 0.513686528794
y4 0.98 11.84 0.408864693437 0.817729386874

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 12.65

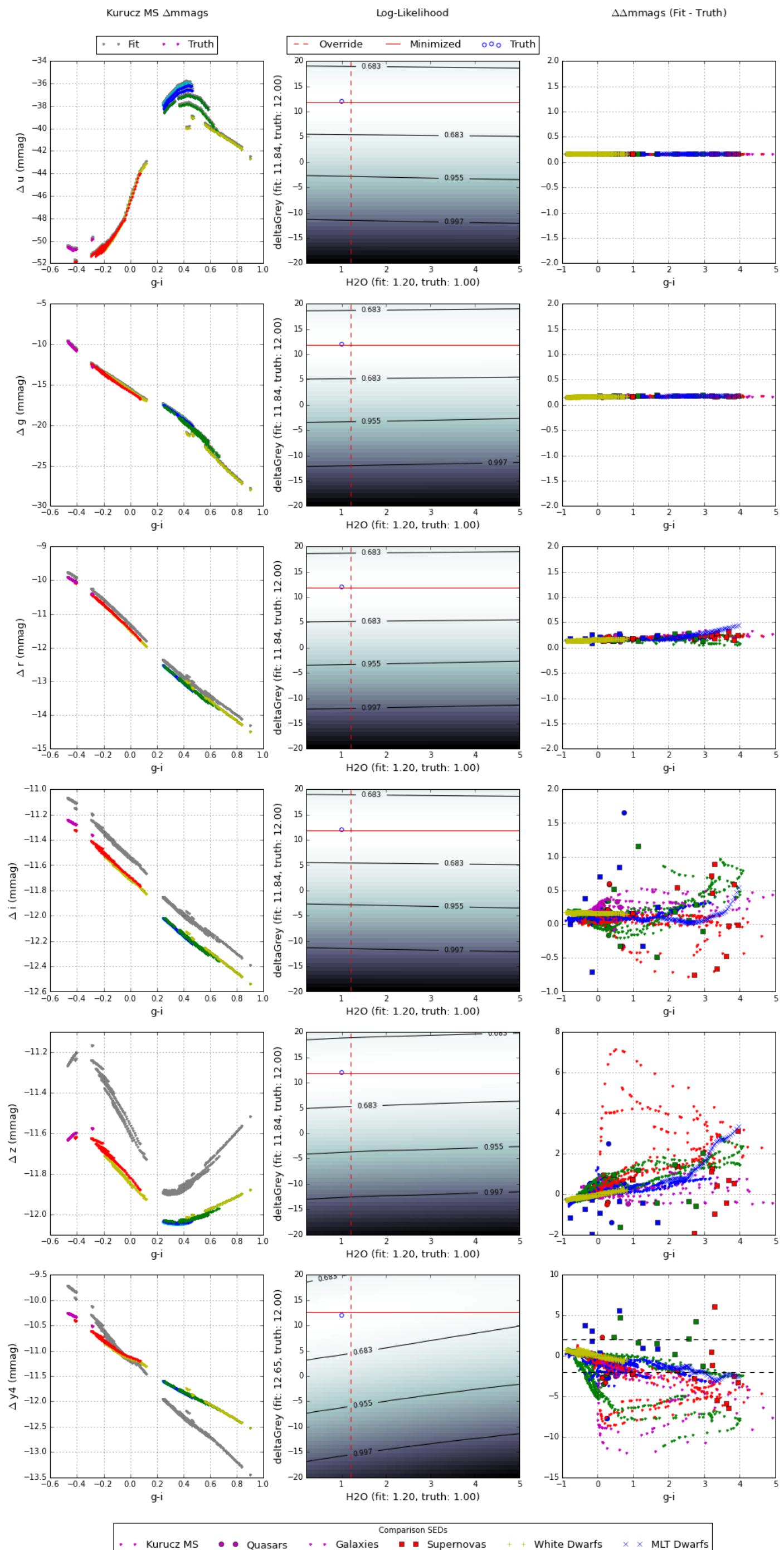
Computing nonlinear regression for H2O.
Observed atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]
Observed atmosphere airmass: 2.0
Standard atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]
Standard atmosphere airmass: 1.2
Observed atmosphere parameter for H2O: 1.0

```

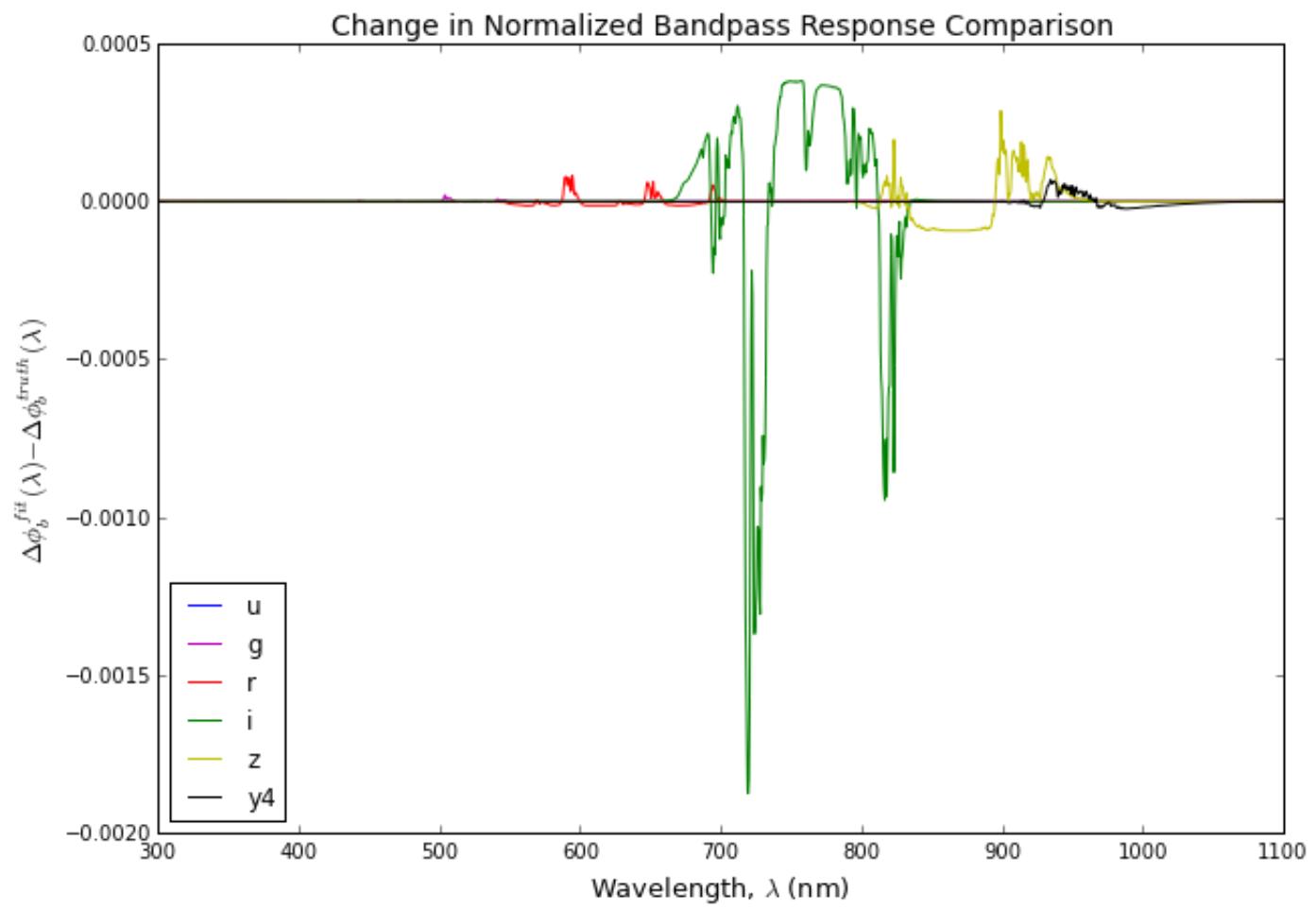
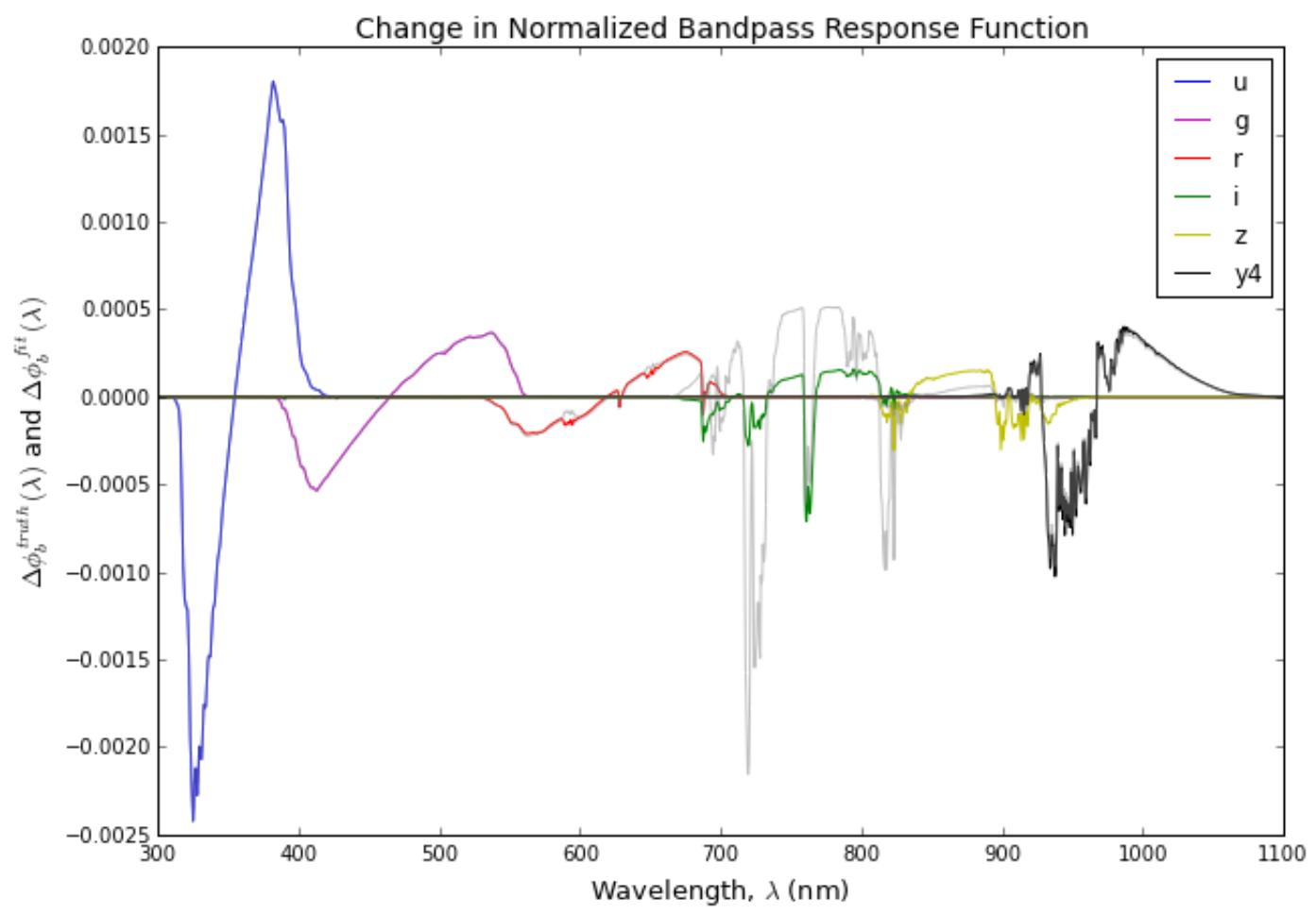
```
Fitting for H2O between 0.20 and 5.00 in 50 bins.  
Fitting for deltaGrey between -20.00 and 20.00 mmags in 50 bins.  
  
Regression SEDs: 988 Kurucz MS SEDs.  
  
Regressing 2500 parameter combinations per filter...  
Magnitude Error: 5.0 mmags  
  
Override triggered...  
Override value detected, 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_H2_O_dG_XSTD12_DG120_DGR-2020_E5_mss_u_50dgb_50b_min_dGTest_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_H2_O_dG_XSTD12_DG120_DGR-2020_E5_mss_g_50dgb_50b_min_dGTest_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_H2_O_dG_XSTD12_DG120_DGR-2020_E5_mss_r_50dgb_50b_min_dGTest_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_H2_O_dG_XSTD12_DG120_DGR-2020_E5_mss_i_50dgb_50b_min_dGTest_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_H2_O_dG_XSTD12_DG120_DGR-2020_E5_mss_z_50dgb_50b_min_dGTest_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_H2_O_dG_XSTD12_DG120_DGR-2020_E5_mss_y4_50dgb_50b_min_dGTest_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 0.272644406703 0.545288813406  
g 0.20 11.84 0.489582382077 0.979164764153  
r 0.30 11.84 0.516304757066 1.03260951413  
i 3.53 11.84 0.404493280882 0.808986561765  
z 0.79 11.84 0.256843264397 0.513686528794  
y4 0.98 11.84 0.408864693437 0.817729386874  
  
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
```



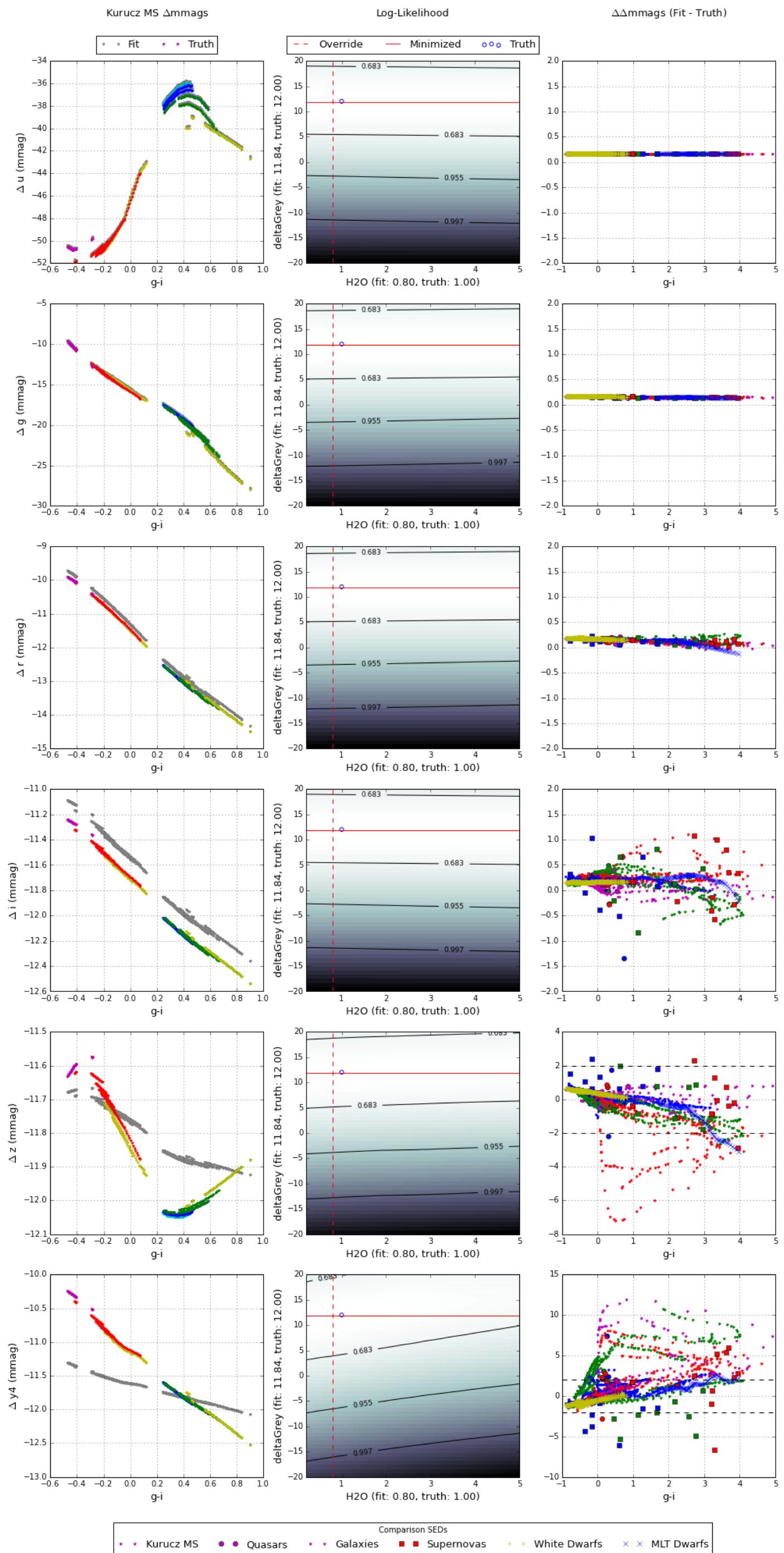
$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey}: 12.0$ )



Comparison SEDs



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



Comparison SEDs

$O_2$

```
In [7]: deltaGreyLimitPlot('O2')
```

```

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: 988 Kurucz MS 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_O2_dG_XSTD12_DG120_DGR-2020_E5_mss_u_51dgb_50b_max_dGTest_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_O2_dG_XSTD12_DG120_DGR-2020_E5_mss_g_51dgb_50b_max_dGTest_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_O2_dG_XSTD12_DG120_DGR-2020_E5_mss_r_51dgb_50b_max_dGTest_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_O2_dG_XSTD12_DG120_DGR-2020_E5_mss_i_51dgb_50b_max_dGTest_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_O2_dG_XSTD12_DG120_DGR-2020_E5_mss_z_51dgb_50b_max_dGTest_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_O2_dG_XSTD12_DG120_DGR-2020_E5_mss_y4_51dgb_50b_max_dGTest_OR120.pkl'
Saved LogL at best fit deltaGrey for y4 filter.
Saved Chi-Squared at best fit deltaGrey for y4 filter.
Completed y4 filter.

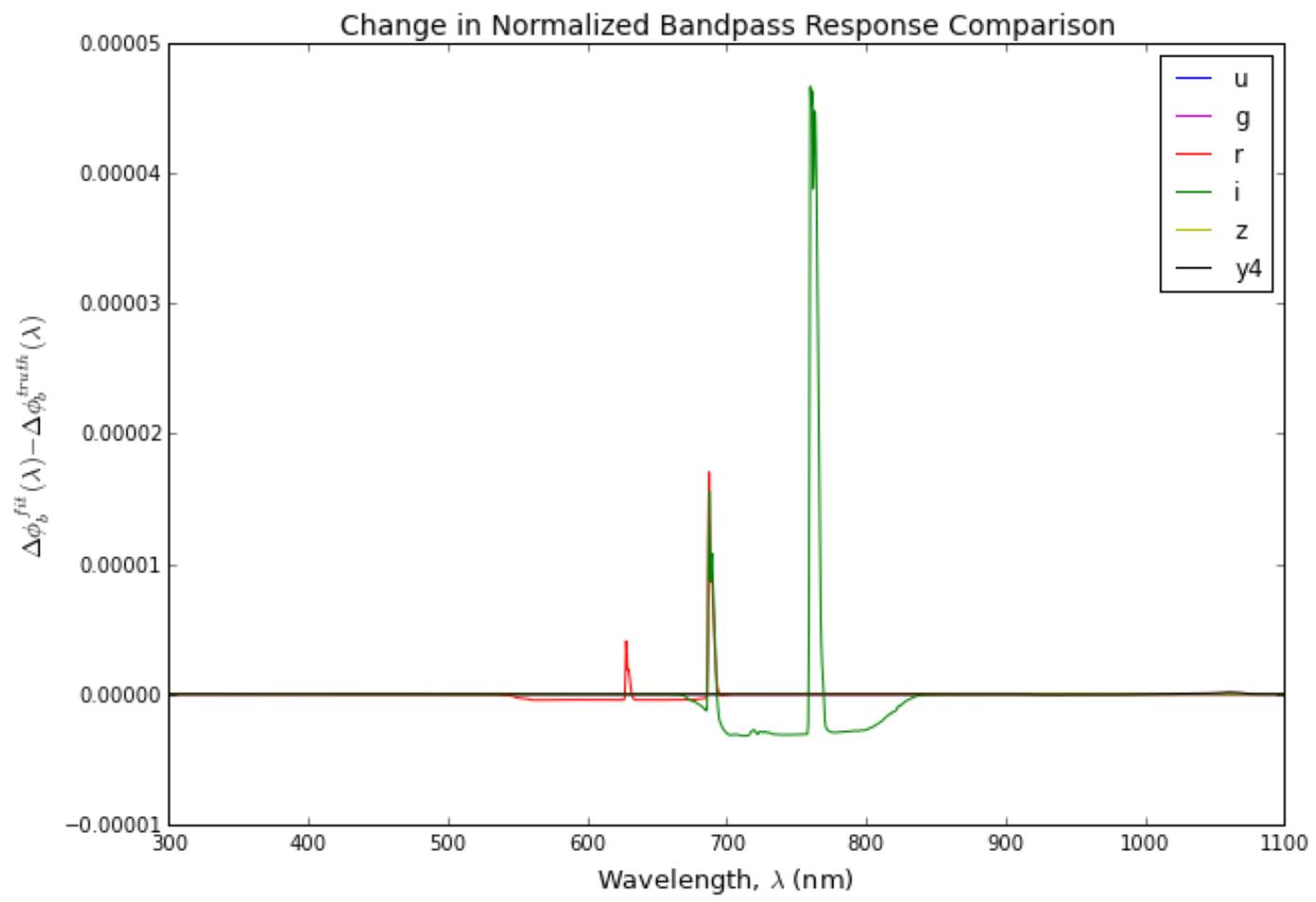
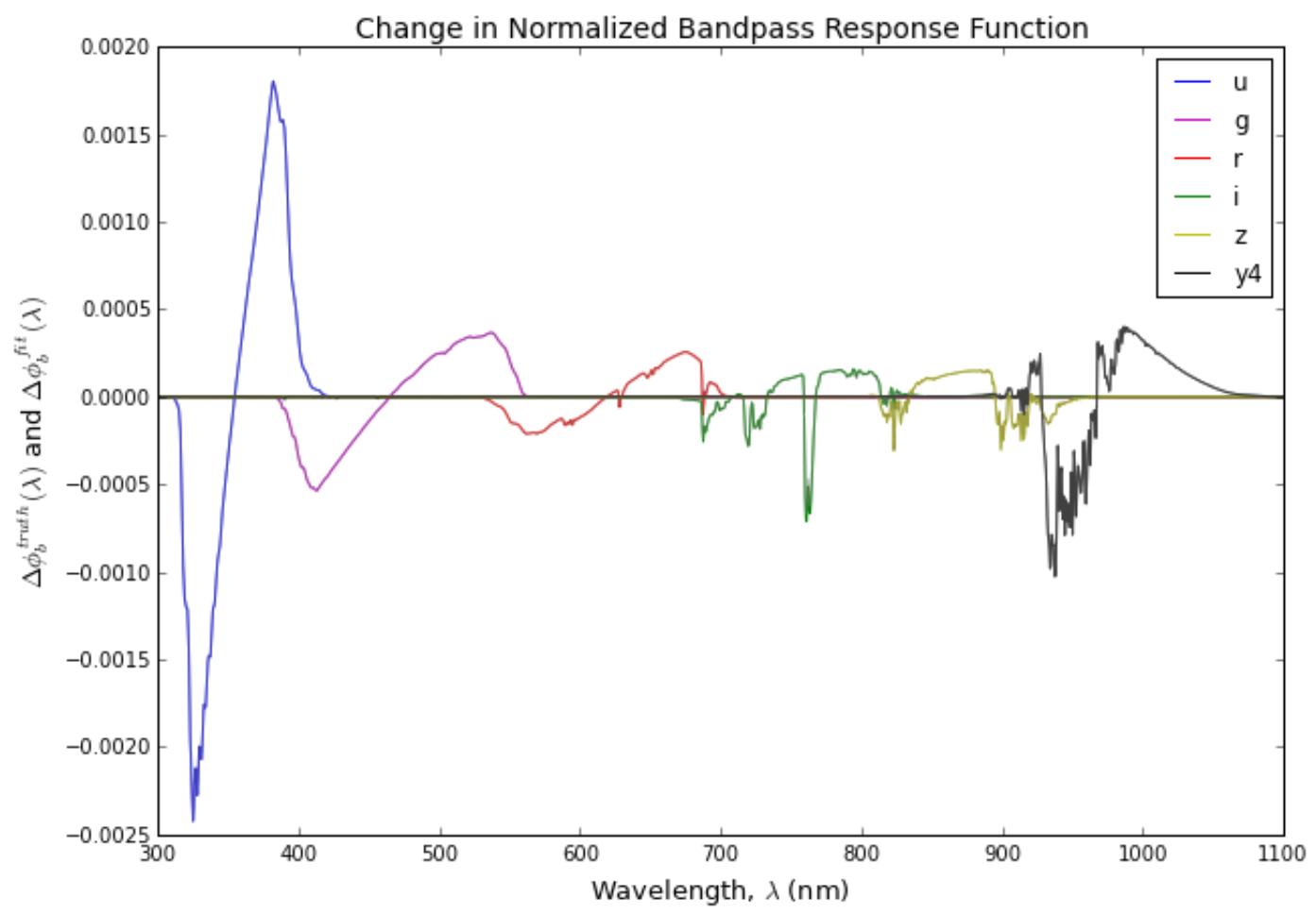
Best fit parameters (Filter, O2, dG, logL, Chi-Squared):
u 0.98 12.00 8.6781601639e-08 1.73563203278e-07
g 0.98 12.00 7.3118594463e-09 1.46237188926e-08
r 0.98 12.00 0.000477505888958 0.000955011777917
i 0.98 12.00 2.4038894124e-05 4.80777882481e-05
z 0.98 12.00 1.33300799564e-09 2.66601599127e-09
y4 0.98 12.00 3.81058381906e-07 7.62116763812e-07

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

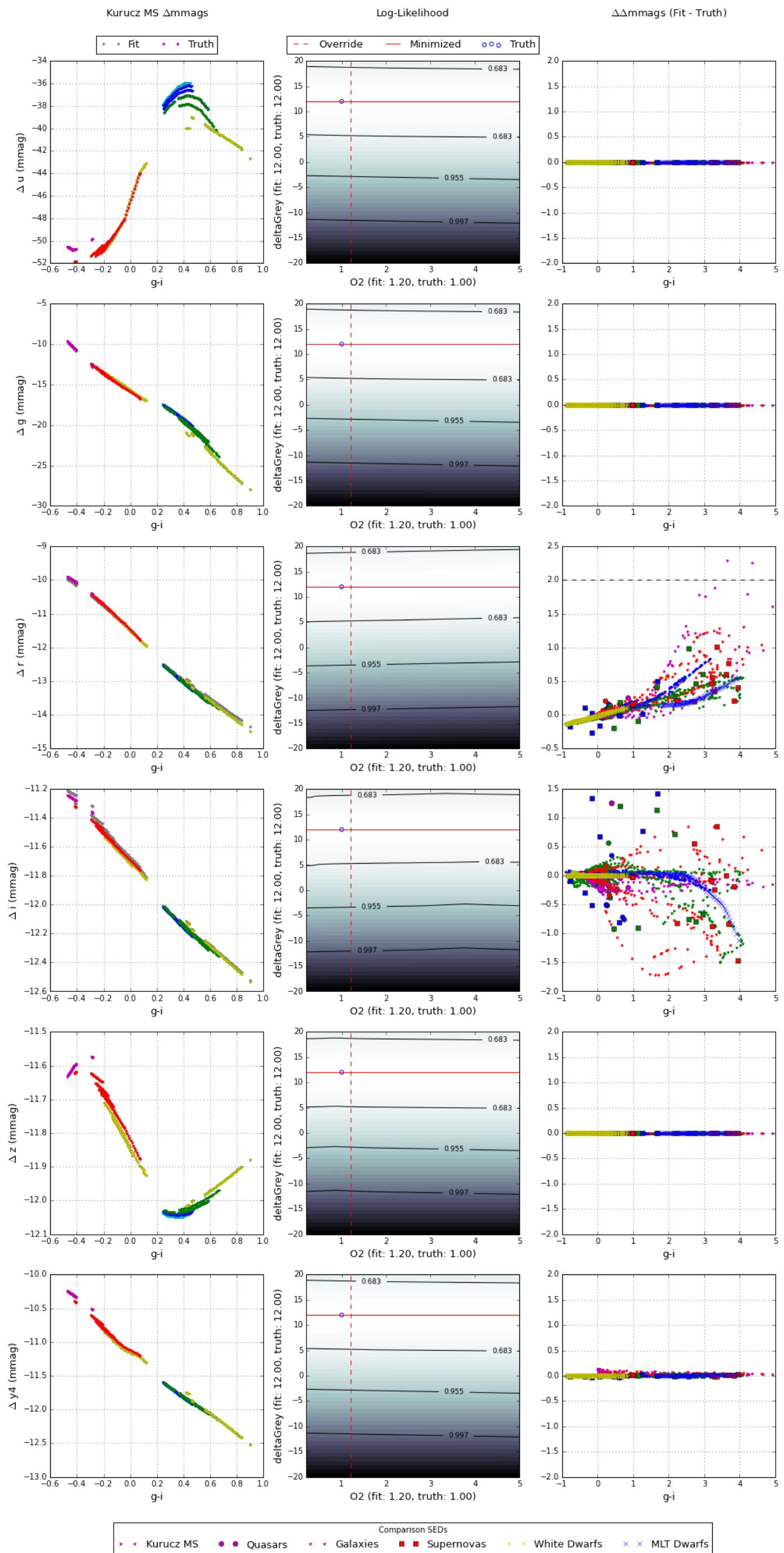
Computing nonlinear regression for O2.
Observed atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]
Observed atmosphere airmass: 2.0
Standard atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]
Standard atmosphere airmass: 1.2
Observed atmosphere parameter for O2: 1.0

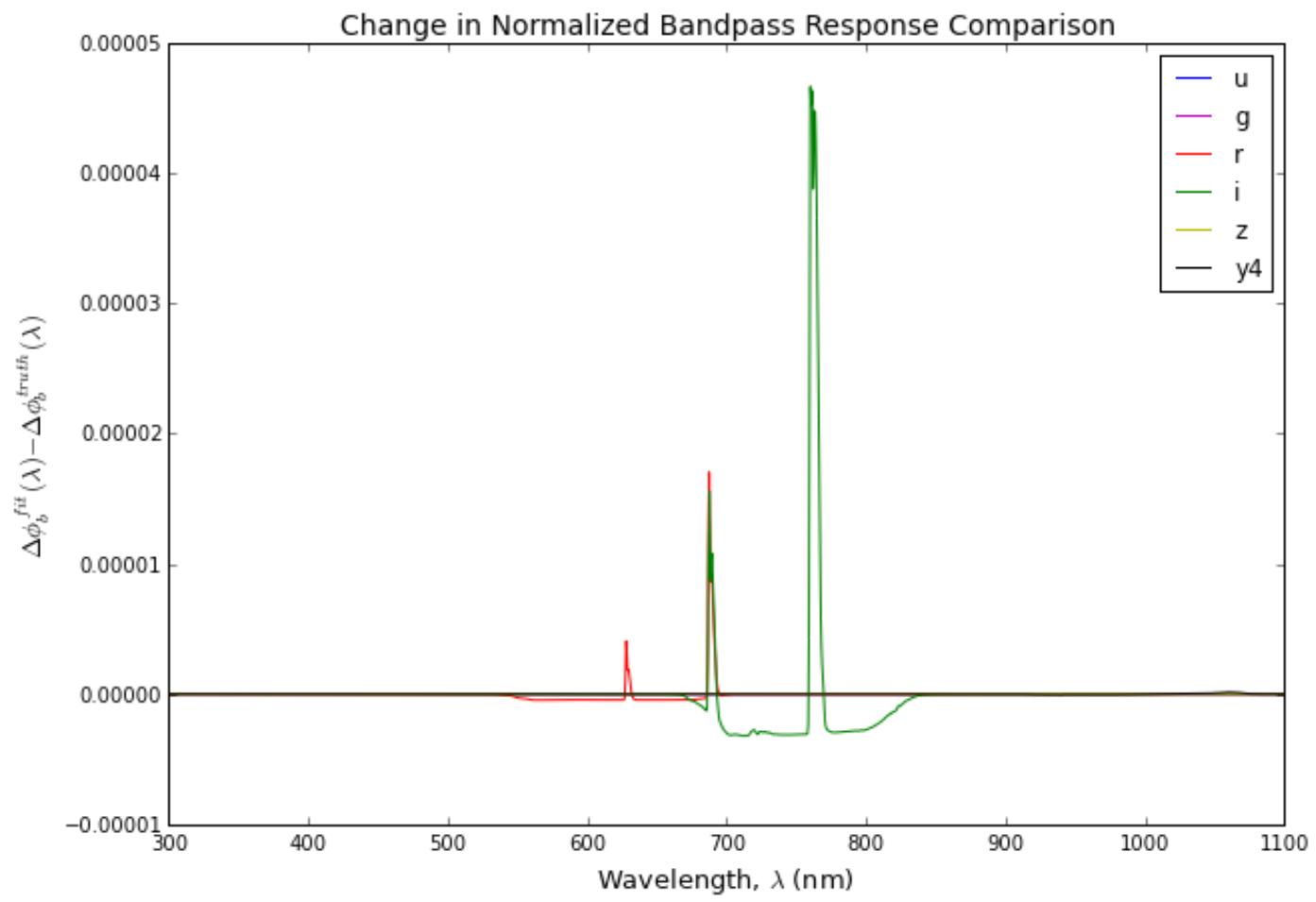
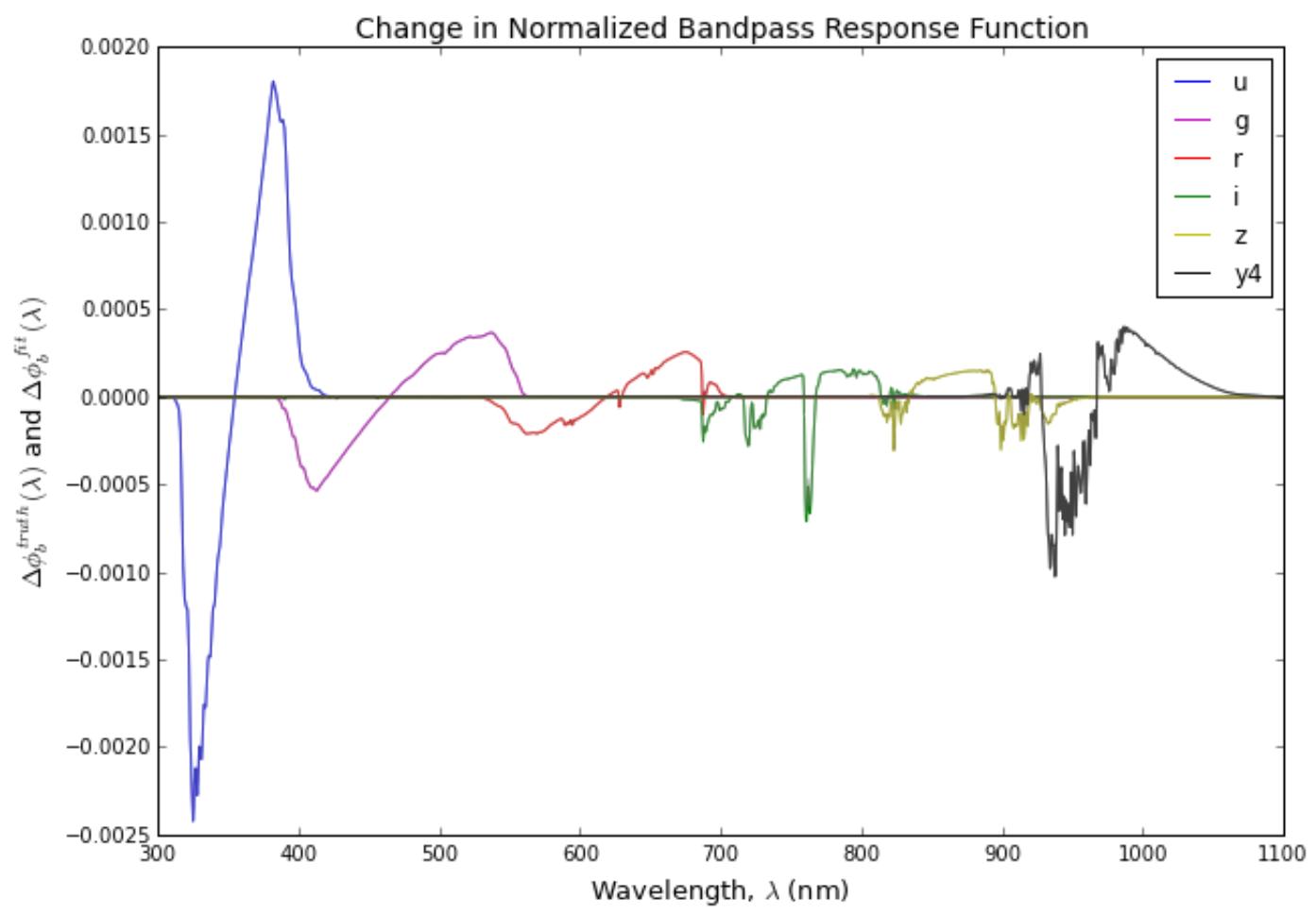
```

```
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: 988 Kurucz MS 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_O2_dG_XSTD12_DG120_DGR-2020_E5_mss_u_51dgb_50b_min_dGTest_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_O2_dG_XSTD12_DG120_DGR-2020_E5_mss_g_51dgb_50b_min_dGTest_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-2020_E5_mss_r_51dgb_50b_min_dGTest_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-2020_E5_mss_i_51dgb_50b_min_dGTest_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-2020_E5_mss_z_51dgb_50b_min_dGTest_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-2020_E5_mss_y4_51dgb_50b_min_dGTest_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 8.6781601639e-08 1.73563203278e-07  
g 0.98 12.00 7.3118594463e-09 1.46237188926e-08  
r 0.98 12.00 0.000477505888958 0.000955011777917  
i 0.98 12.00 2.4038894124e-05 4.80777882481e-05  
z 0.98 12.00 1.33300799564e-09 2.66601599127e-09  
y4 0.98 12.00 3.81058381906e-07 7.62116763812e-07  
  
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
```

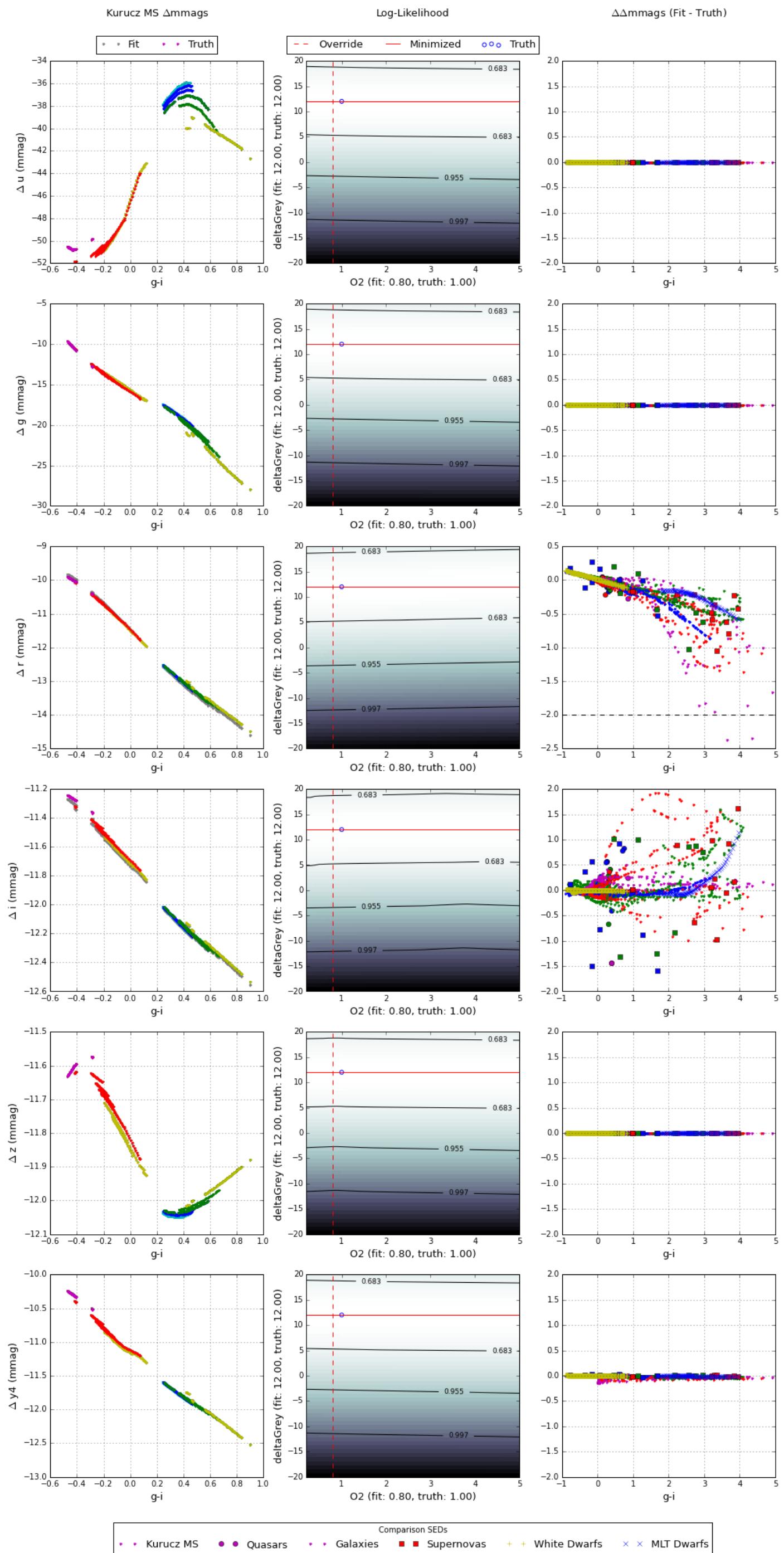


$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey}$ : 12.0)





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



```
In [8]: deltaGreyLimitPlot('O2',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: 988 Kurucz MS 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_O2_dG_XSTD12_DG120_DGR-2020_E5_mss_u_50dgb_50b_max_dGTest_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_O2_dG_XSTD12_DG120_DGR-2020_E5_mss_g_50dgb_50b_max_dGTest_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_O2_dG_XSTD12_DG120_DGR-2020_E5_mss_r_50dgb_50b_max_dGTest_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_O2_dG_XSTD12_DG120_DGR-2020_E5_mss_i_50dgb_50b_max_dGTest_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_O2_dG_XSTD12_DG120_DGR-2020_E5_mss_z_50dgb_50b_max_dGTest_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_O2_dG_XSTD12_DG120_DGR-2020_E5_mss_y4_50dgb_50b_max_dGTest_OR120.pkl'
Saved LogL at best fit deltaGrey for y4 filter.
Saved Chi-Squared at best fit deltaGrey for y4 filter.
Completed y4 filter.

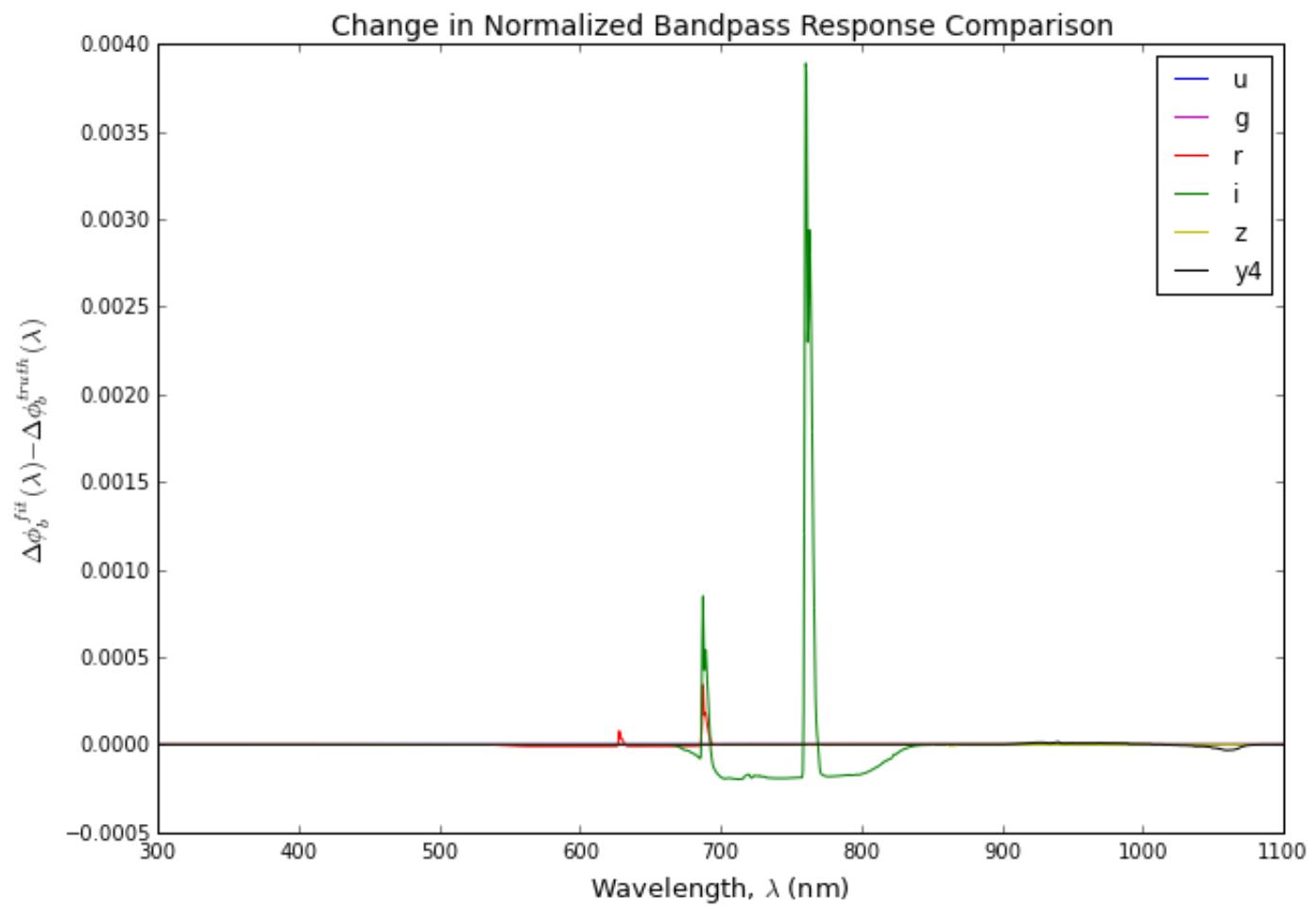
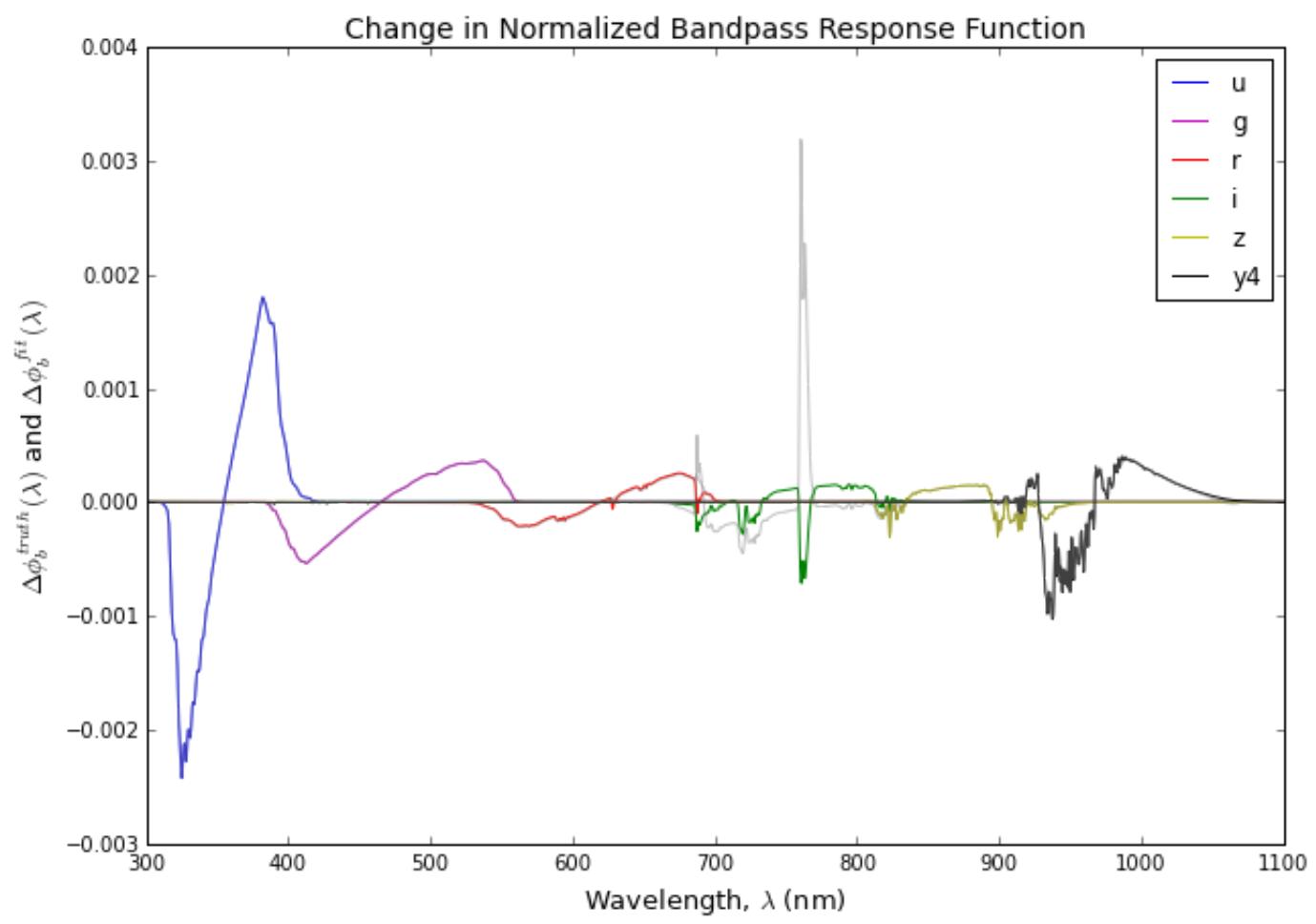
Best fit parameters (Filter, O2, dG, logL, Chi-Squared):
u 5.00 11.84 0.460592152288 0.921184304577
g 5.00 11.84 0.509536267472 1.01907253494
r 0.69 11.84 0.297007580005 0.594015160009
i 0.20 11.84 0.207817091924 0.415634183848
z 5.00 11.84 0.525142999879 1.05028599976
y4 5.00 11.84 0.403598341406 0.807196682812

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

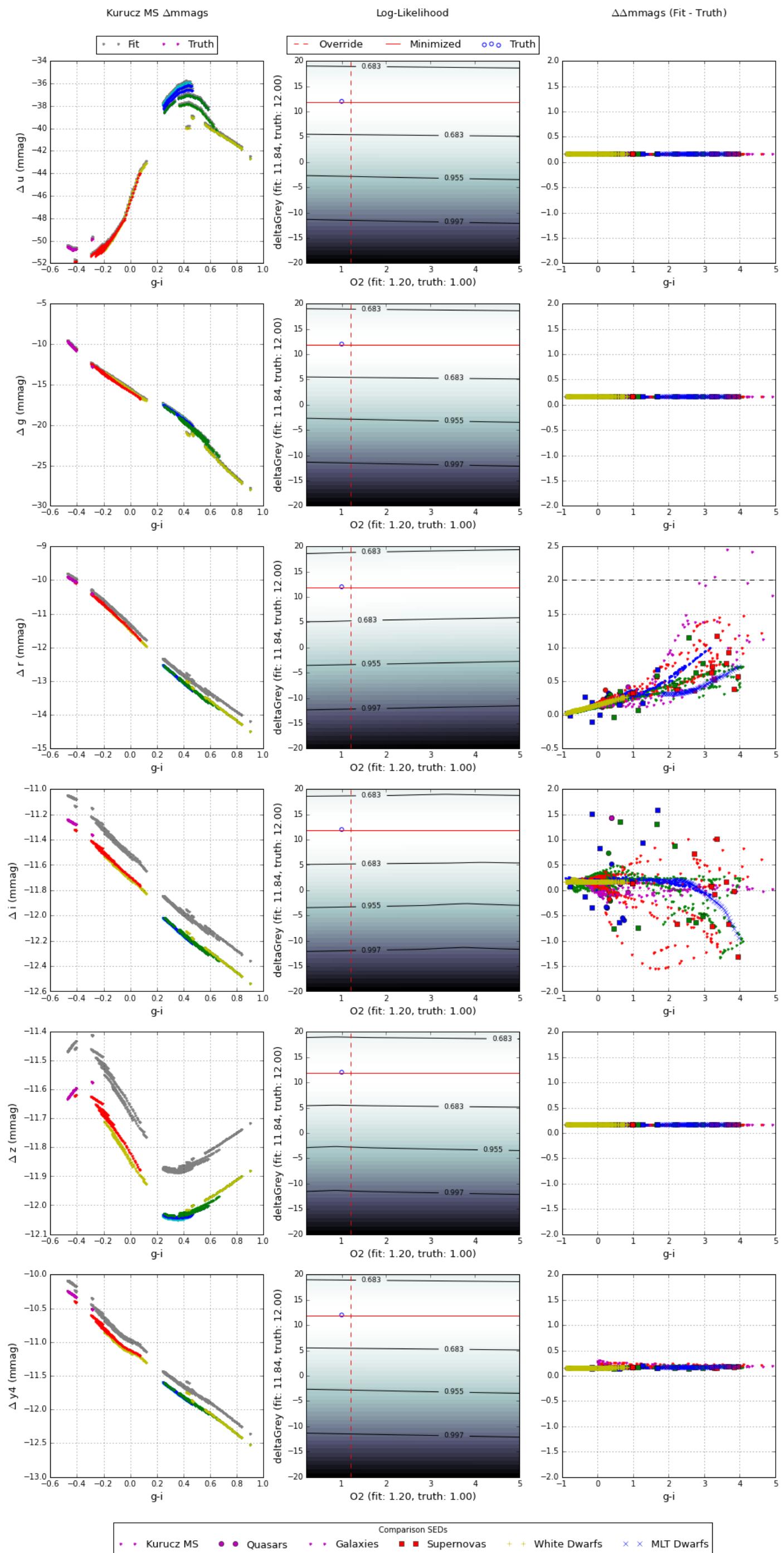
Computing nonlinear regression for O2.
Observed atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]
Observed atmosphere airmass: 2.0
Standard atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]
Standard atmosphere airmass: 1.2
Observed atmosphere parameter for O2: 1.0

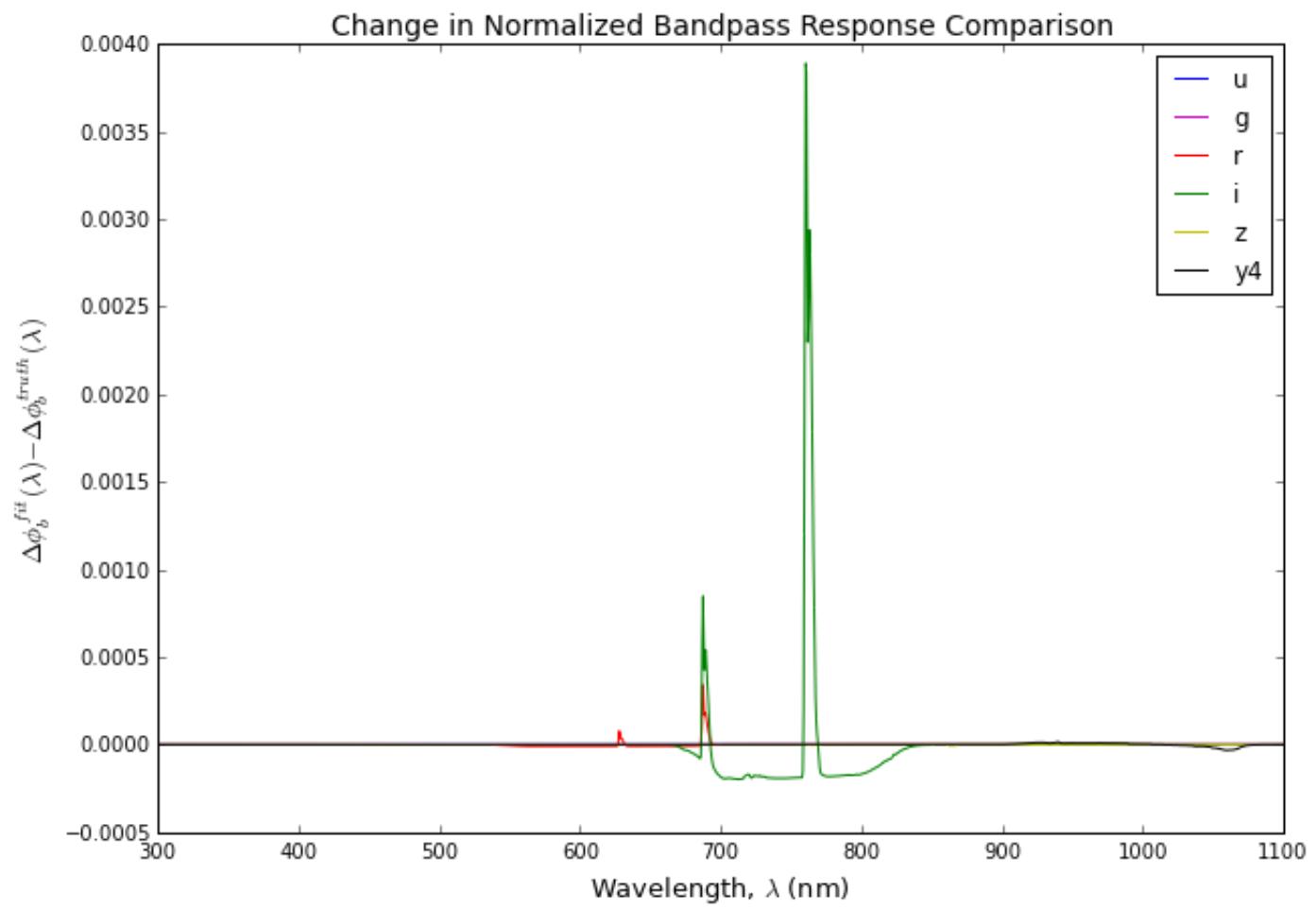
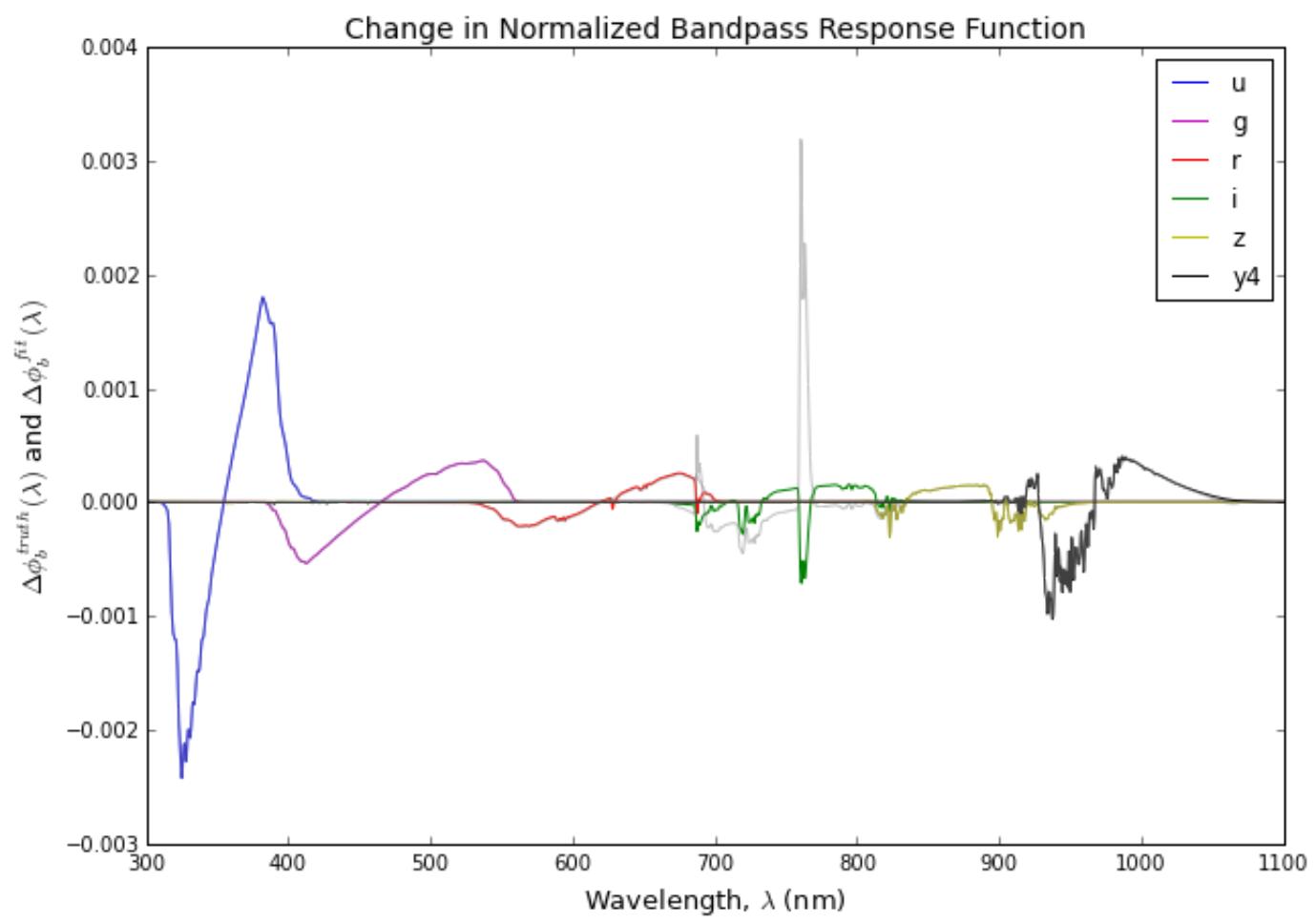
```

```
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: 988 Kurucz MS 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_O2_dG_XSTD12_DG120_DGR-2020_E5_mss_u_50dgb_50b_min_dGTest_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_O2_dG_XSTD12_DG120_DGR-2020_E5_mss_g_50dgb_50b_min_dGTest_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-2020_E5_mss_r_50dgb_50b_min_dGTest_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-2020_E5_mss_i_50dgb_50b_min_dGTest_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-2020_E5_mss_z_50dgb_50b_min_dGTest_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-2020_E5_mss_y4_50dgb_50b_min_dGTest_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 0.460592152288 0.921184304577  
g 5.00 11.84 0.509536267472 1.01907253494  
r 0.69 11.84 0.297007580005 0.594015160009  
i 0.20 11.84 0.207817091924 0.415634183848  
z 5.00 11.84 0.525142999879 1.05028599976  
y4 5.00 11.84 0.403598341406 0.807196682812  
  
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
```

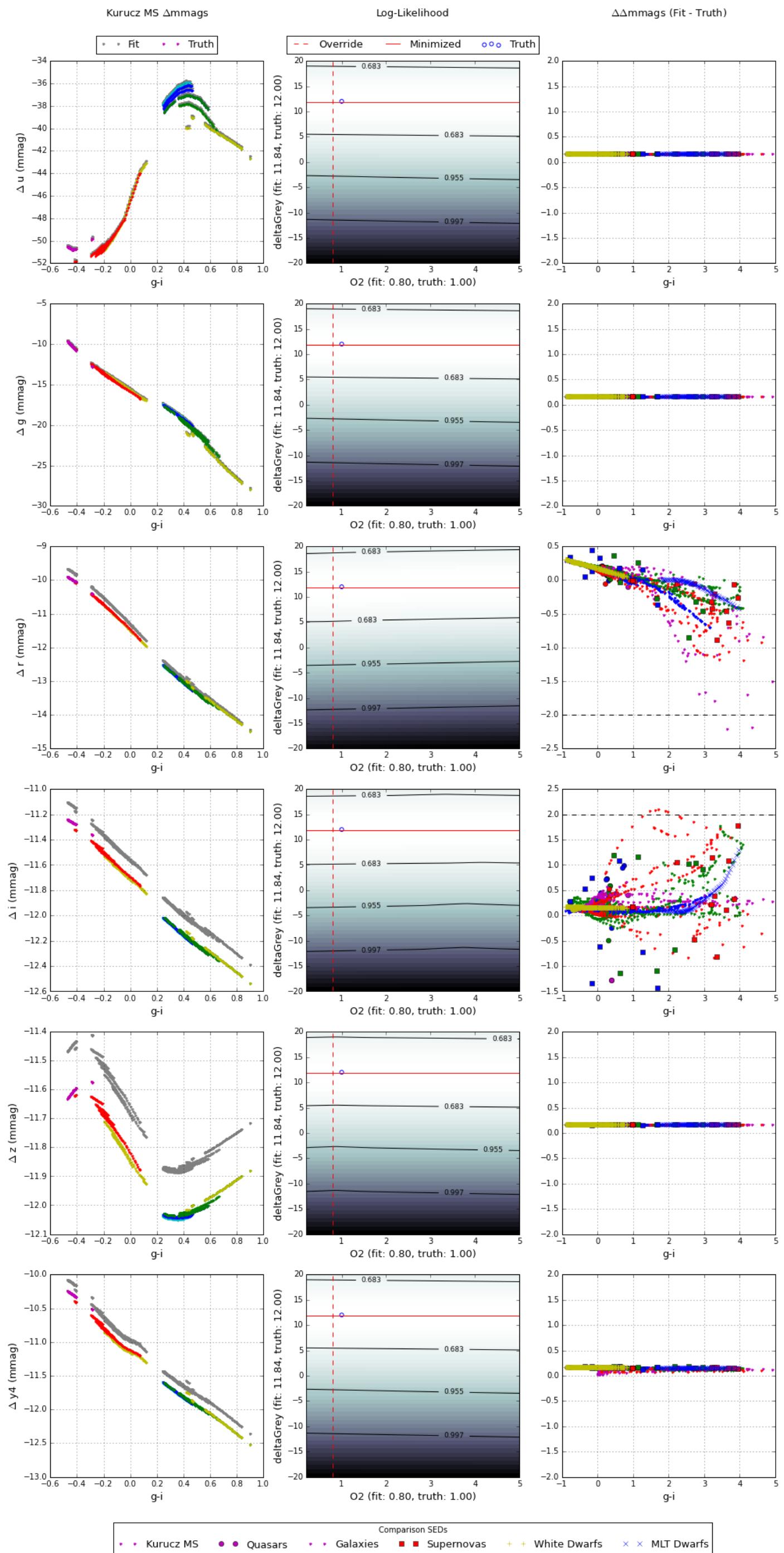


$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey}$ : 12.0)





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



$O_3$

```
In [9]: deltaGreyLimitPlot('O3')
```

```

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: 988 Kurucz MS 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_DGR-2020_E5_mss_u_51dgb_50b_max_dGTest_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_DGR-2020_E5_mss_g_51dgb_50b_max_dGTest_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_DGR-2020_E5_mss_r_51dgb_50b_max_dGTest_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_DGR-2020_E5_mss_i_51dgb_50b_max_dGTest_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_DGR-2020_E5_mss_z_51dgb_50b_max_dGTest_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_DGR-2020_E5_mss_y4_51dgb_50b_max_dGTest_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 0.407030720083 0.814061440165
g 0.98 12.00 0.0329036063685 0.0658072127371
r 0.98 12.00 0.00487938556147 0.00975877112294
i 0.98 12.00 0.000105382658892 0.000210765317784
z 0.98 12.00 7.69171497769e-07 1.53834299554e-06
y4 0.98 12.00 3.87763801608e-07 7.75527603217e-07

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: 988 Kurucz MS 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-2020_E5_mss_u_51dgb_50b_min_dGTest_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-2020_E5_mss_g_51dgb_50b_min_dGTest_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-2020_E5_mss_r_51dgb_50b_min_dGTest_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-2020_E5_mss_i_51dgb_50b_min_dGTest_OR80.pkl'
Saved LogL at best fit deltaGrey for i filter.
Saved Chi-Squared at best fit deltaGrey for i filter.
Completed i filter.

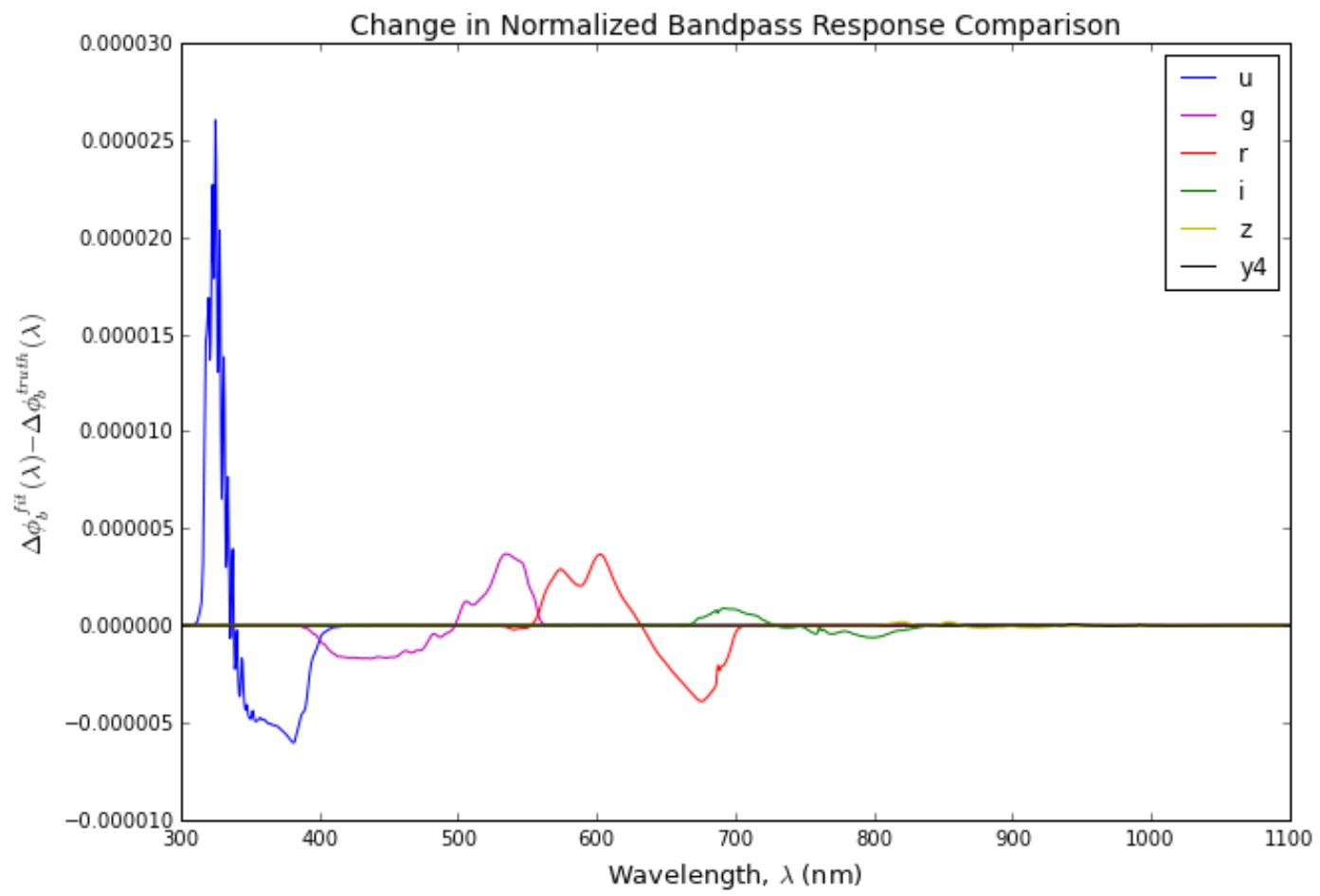
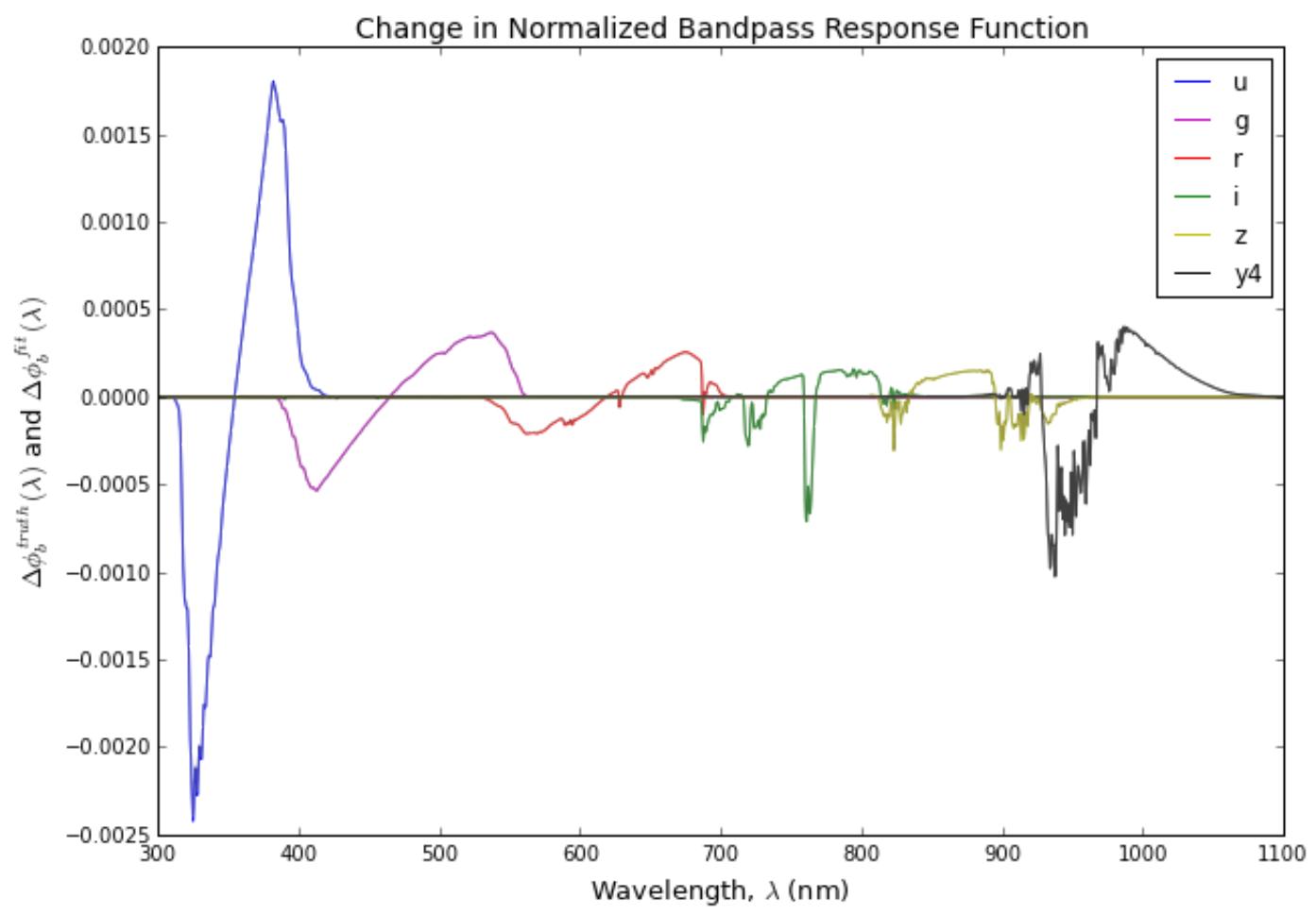
Calculating best fit parameters for z filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_O3_dG_XSTD12_DG120_DGR-2020_E5_mss_z_51dgb_50b_min_dGTest_OR80.pkl'
Saved LogL at best fit deltaGrey for z filter.
Saved Chi-Squared at best fit deltaGrey for z filter.
Completed z filter.

Calculating best fit parameters for y4 filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_O3_dG_XSTD12_DG120_DGR-2020_E5_mss_y4_51dgb_50b_min_dGTest_OR80.pkl'
Saved LogL at best fit deltaGrey for y4 filter.
Saved Chi-Squared at best fit deltaGrey for y4 filter.
Completed y4 filter.

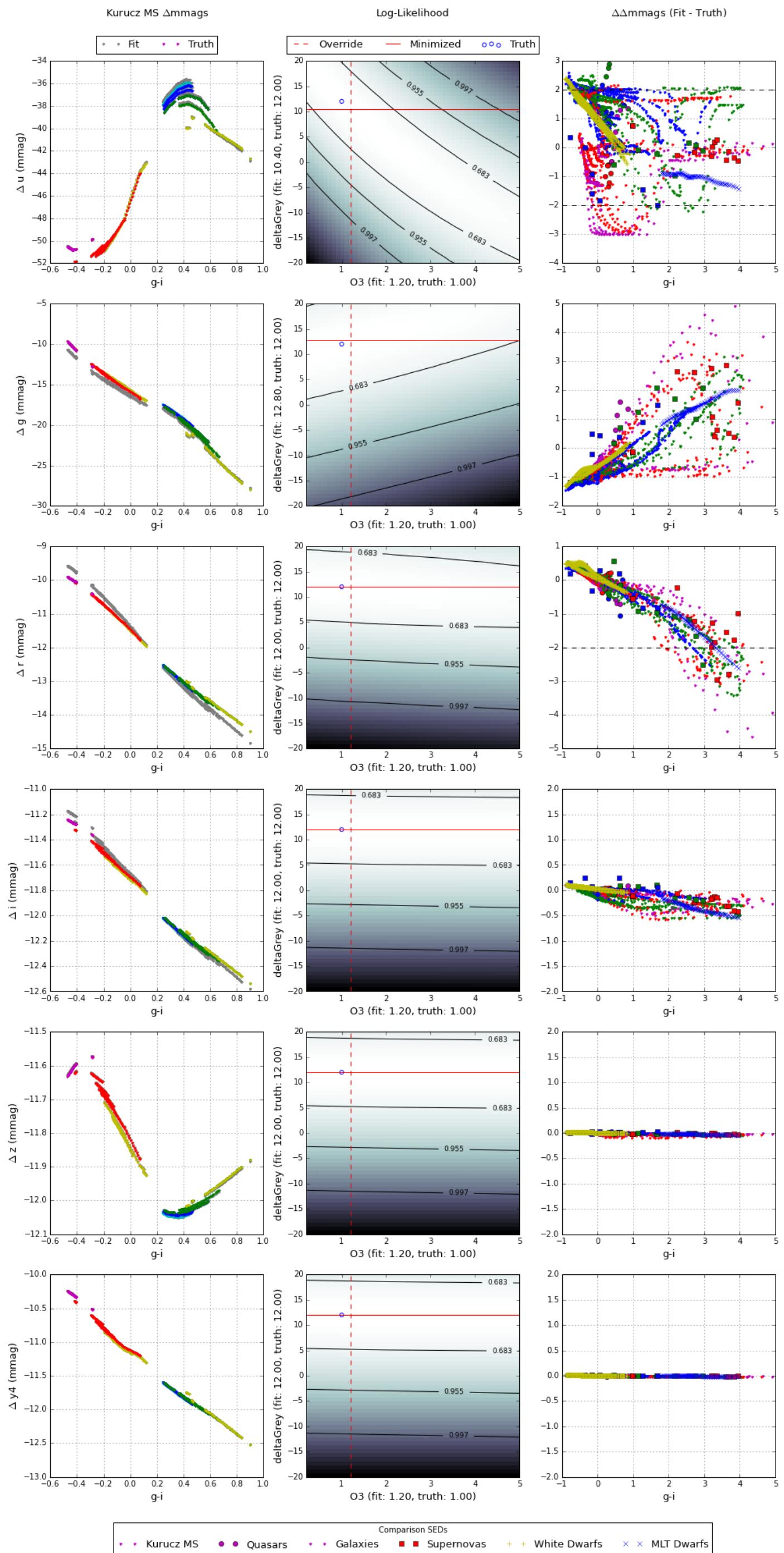
Best fit parameters (Filter, O3, dG, logL, Chi-Squared):
u 0.98 12.00 0.407030720083 0.814061440165
g 0.98 12.00 0.0329036063685 0.0658072127371
r 0.98 12.00 0.00487938556147 0.00975877112294
i 0.98 12.00 0.000105382658892 0.000210765317784
z 0.98 12.00 7.69171497769e-07 1.53834299554e-06
y4 0.98 12.00 3.87763801608e-07 7.75527603217e-07

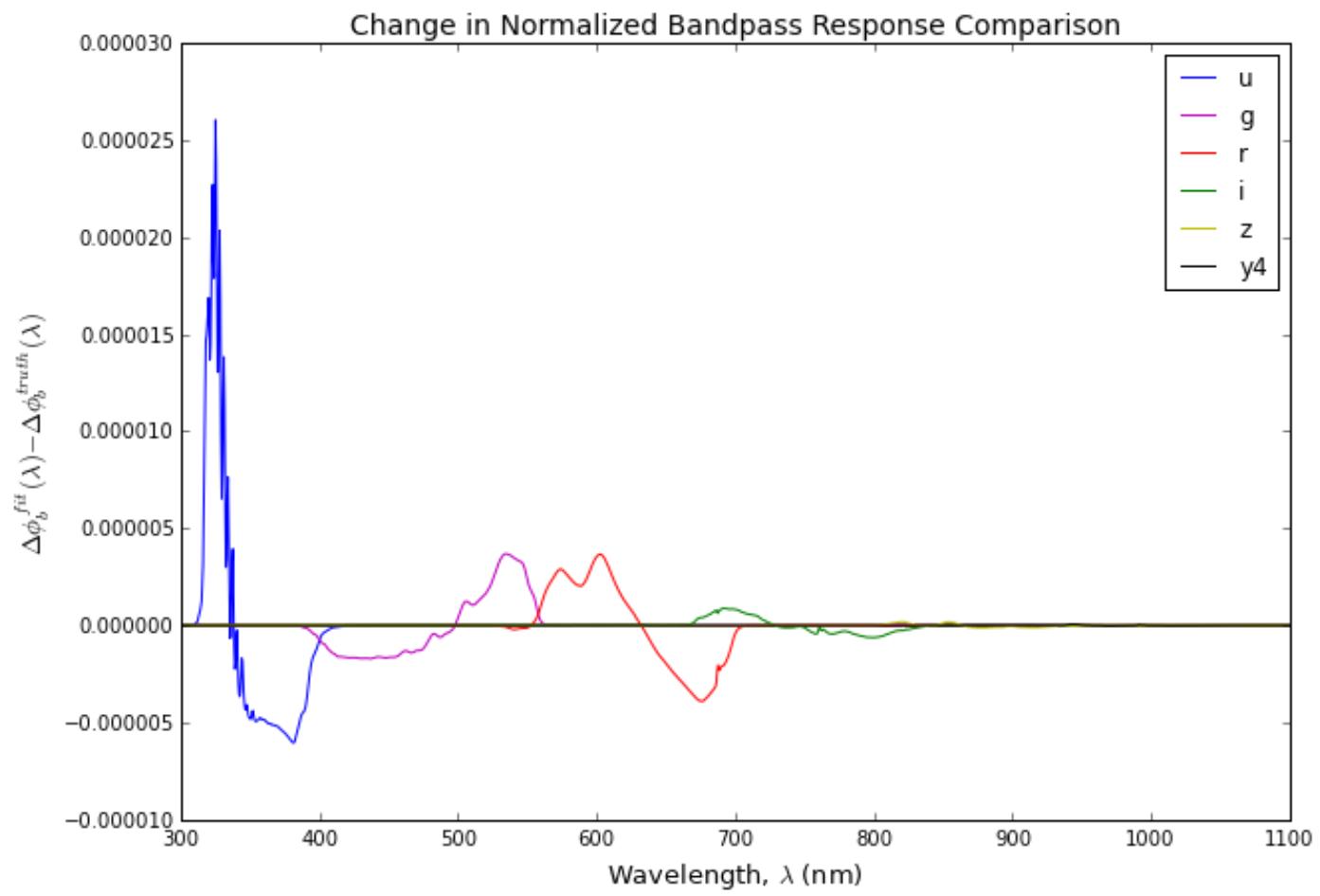
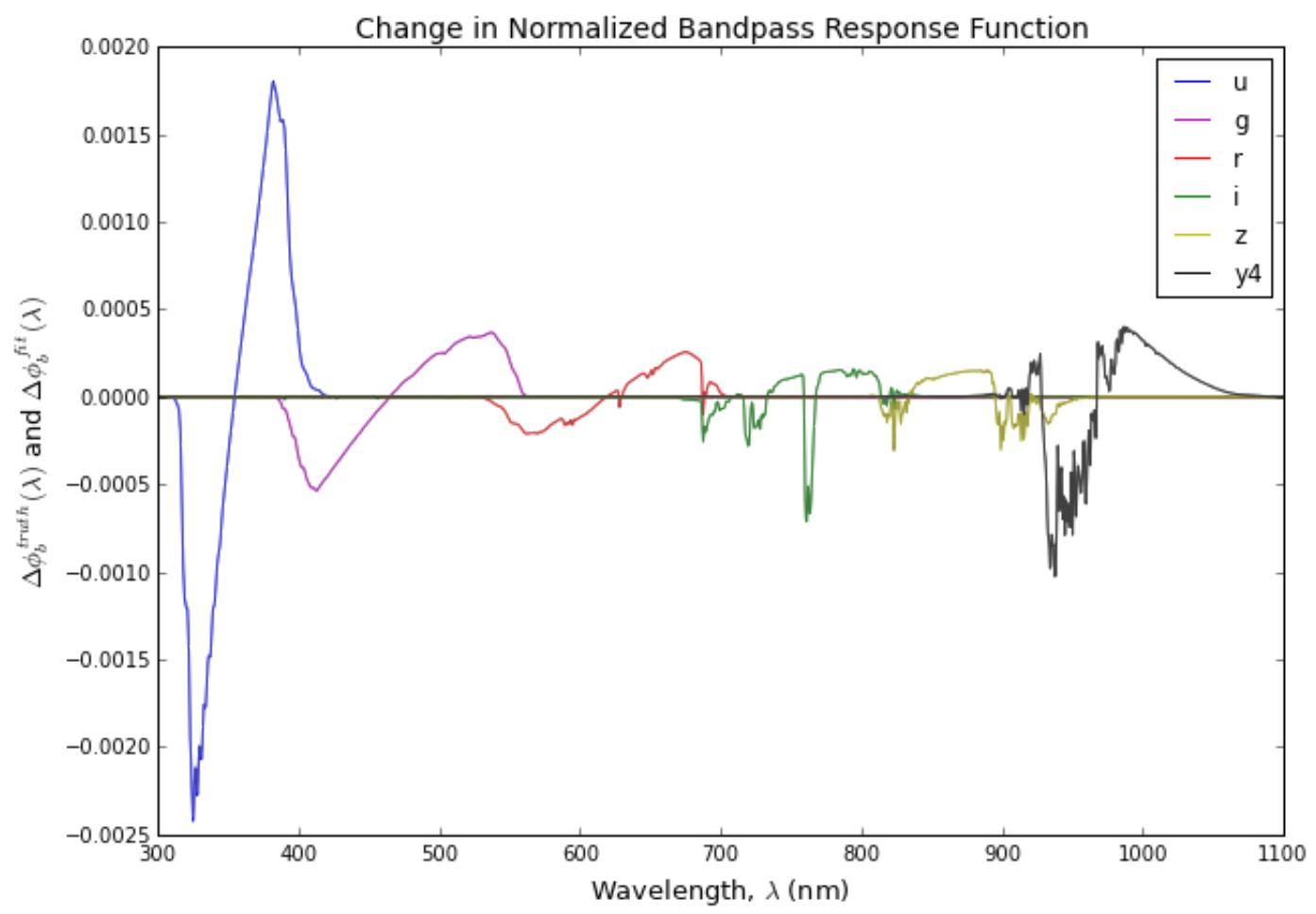
Override best fit parameters (Filter, O3, dG):
u 0.80 13.60
g 0.80 11.20
r 0.80 12.00
i 0.80 12.00
z 0.80 12.00
y4 0.80 12.00

```

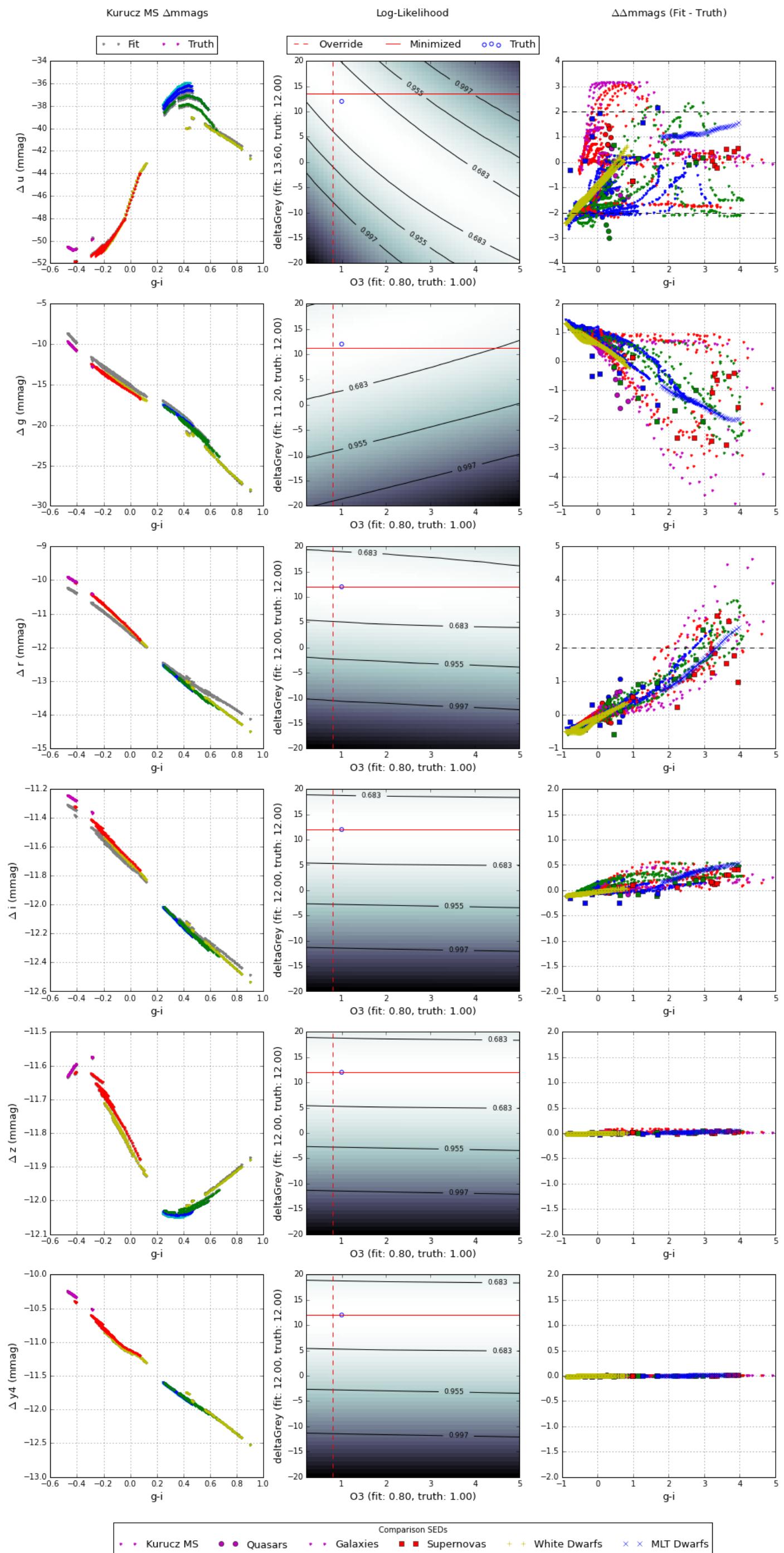


$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey}$ : 12.0)





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



```
In [10]: deltaGreyLimitPlot('O3',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: 988 Kurucz MS 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-2020_E5_mss_u_50dgb_50b_max_dGTest_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-2020_E5_mss_g_50dgb_50b_max_dGTest_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-2020_E5_mss_r_50dgb_50b_max_dGTest_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-2020_E5_mss_i_50dgb_50b_max_dGTest_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-2020_E5_mss_z_50dgb_50b_max_dGTest_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-2020_E5_mss_y4_50dgb_50b_max_dGTest_OR120.pkl'
Saved LogL at best fit deltaGrey for y4 filter.
Saved Chi-Squared at best fit deltaGrey for y4 filter.
Completed y4 filter.

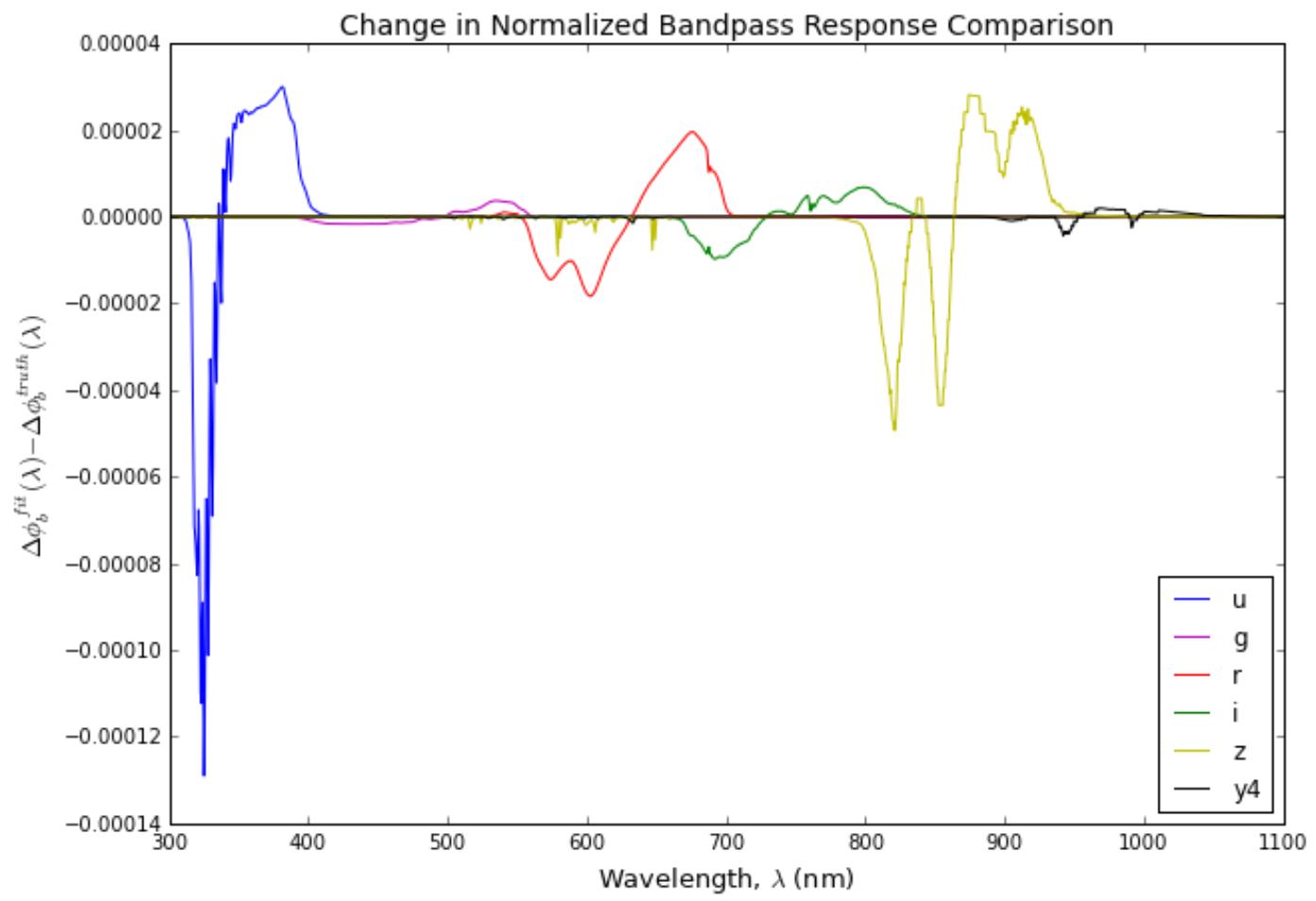
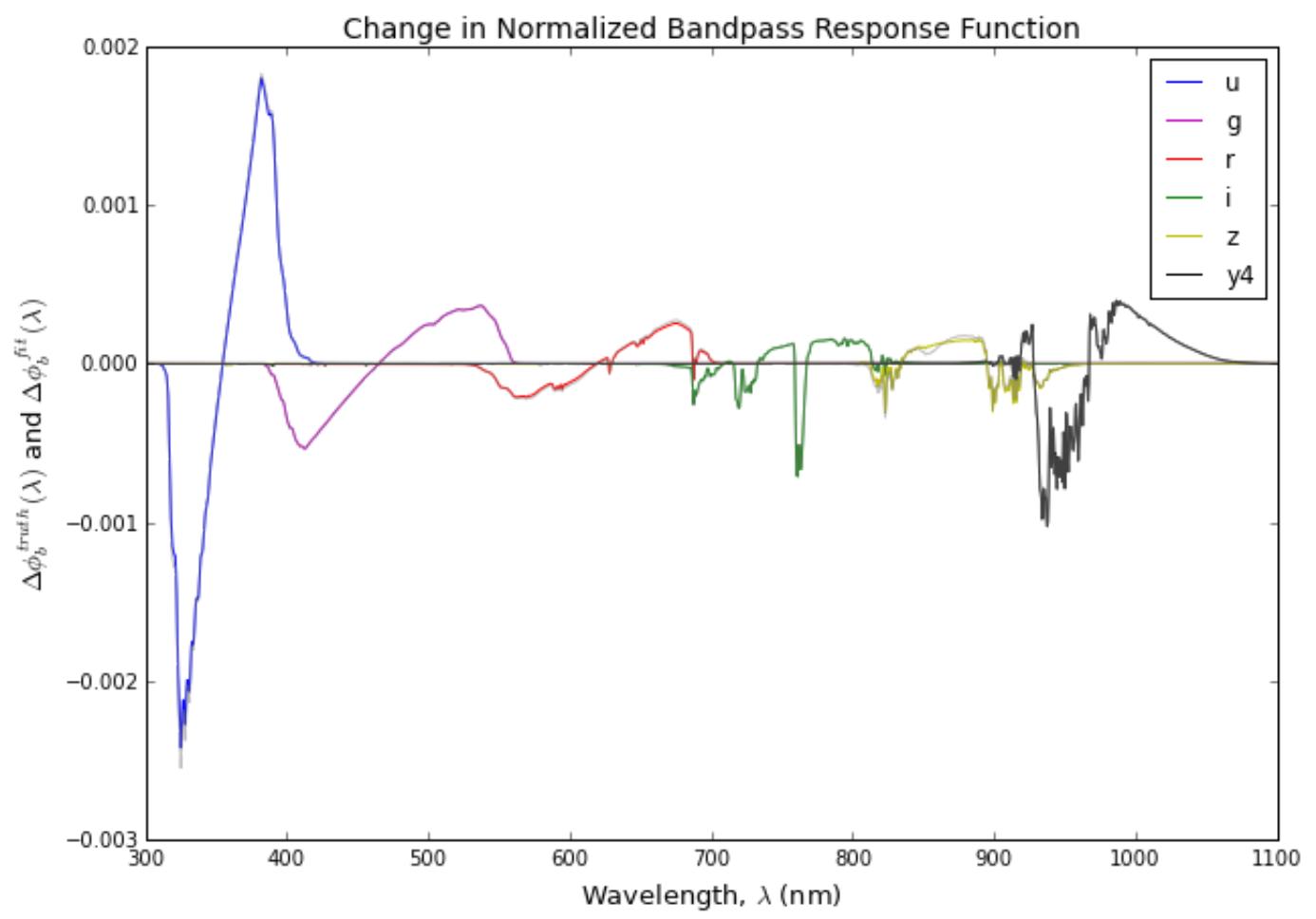
Best fit parameters (Filter, O3, dG, logL, Chi-Squared):
u 1.08 11.02 1.84529956913 3.69059913827
g 0.98 11.84 0.333507316062 0.667014632123
r 1.08 11.84 0.402694027115 0.80538805423
i 1.18 11.84 0.511180313834 1.02236062767
z 5.00 11.84 0.451472124398 0.902944248795
y4 1.96 11.84 0.525220740898 1.0504414818

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

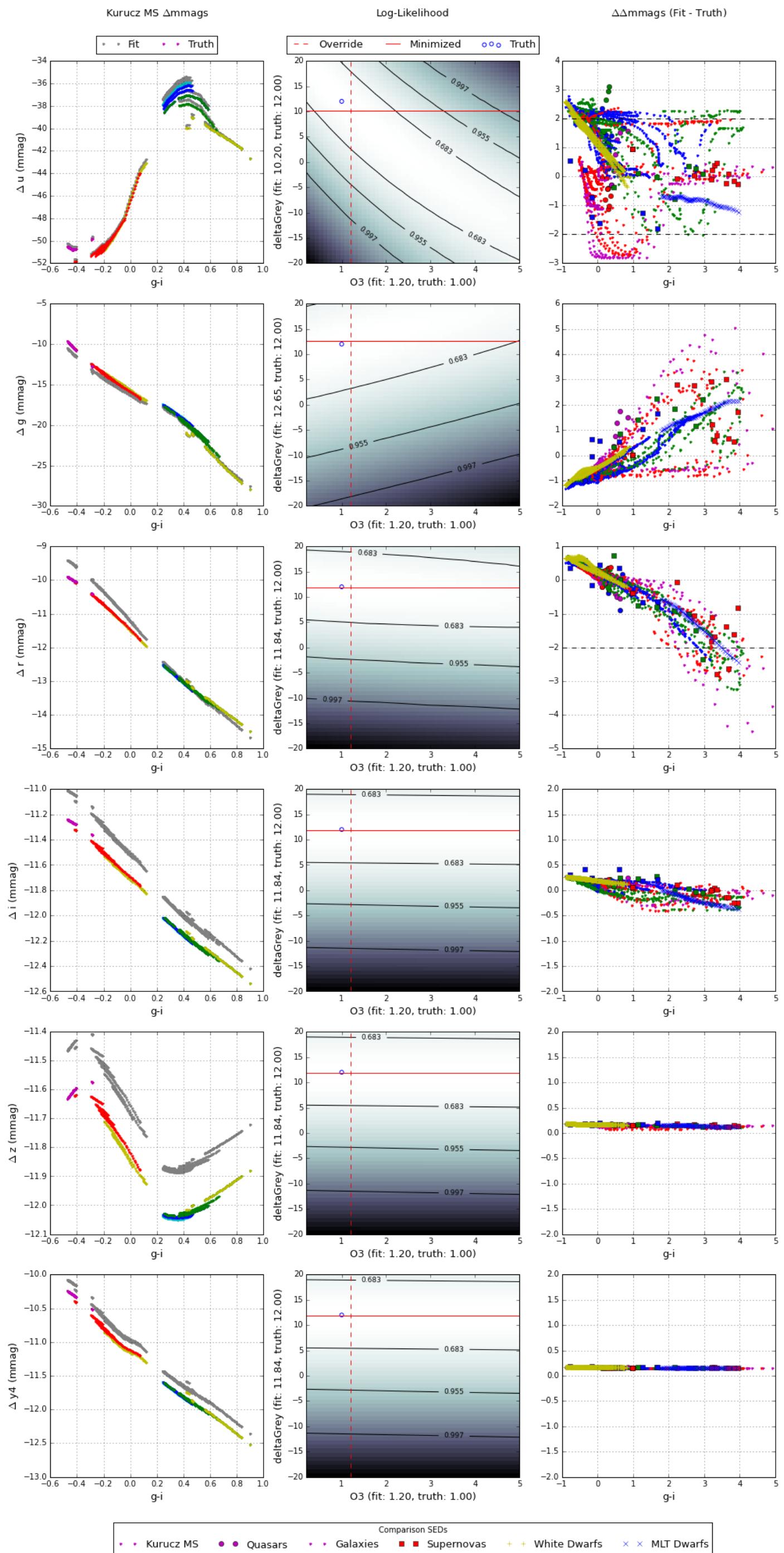
Computing nonlinear regression for O3.
Observed atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]
Observed atmosphere airmass: 2.0
Standard atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]
Standard atmosphere airmass: 1.2
Observed atmosphere parameter for O3: 1.0

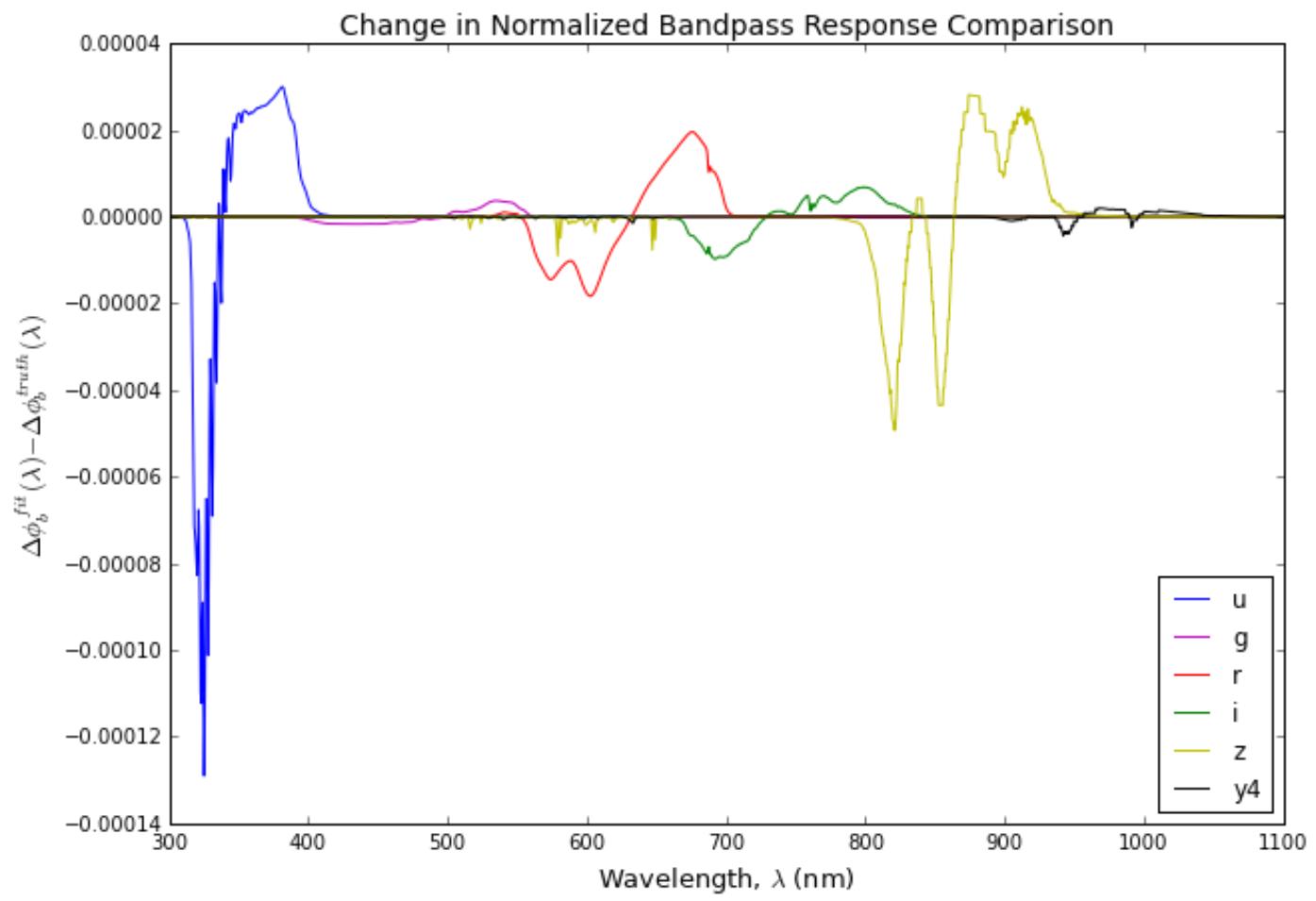
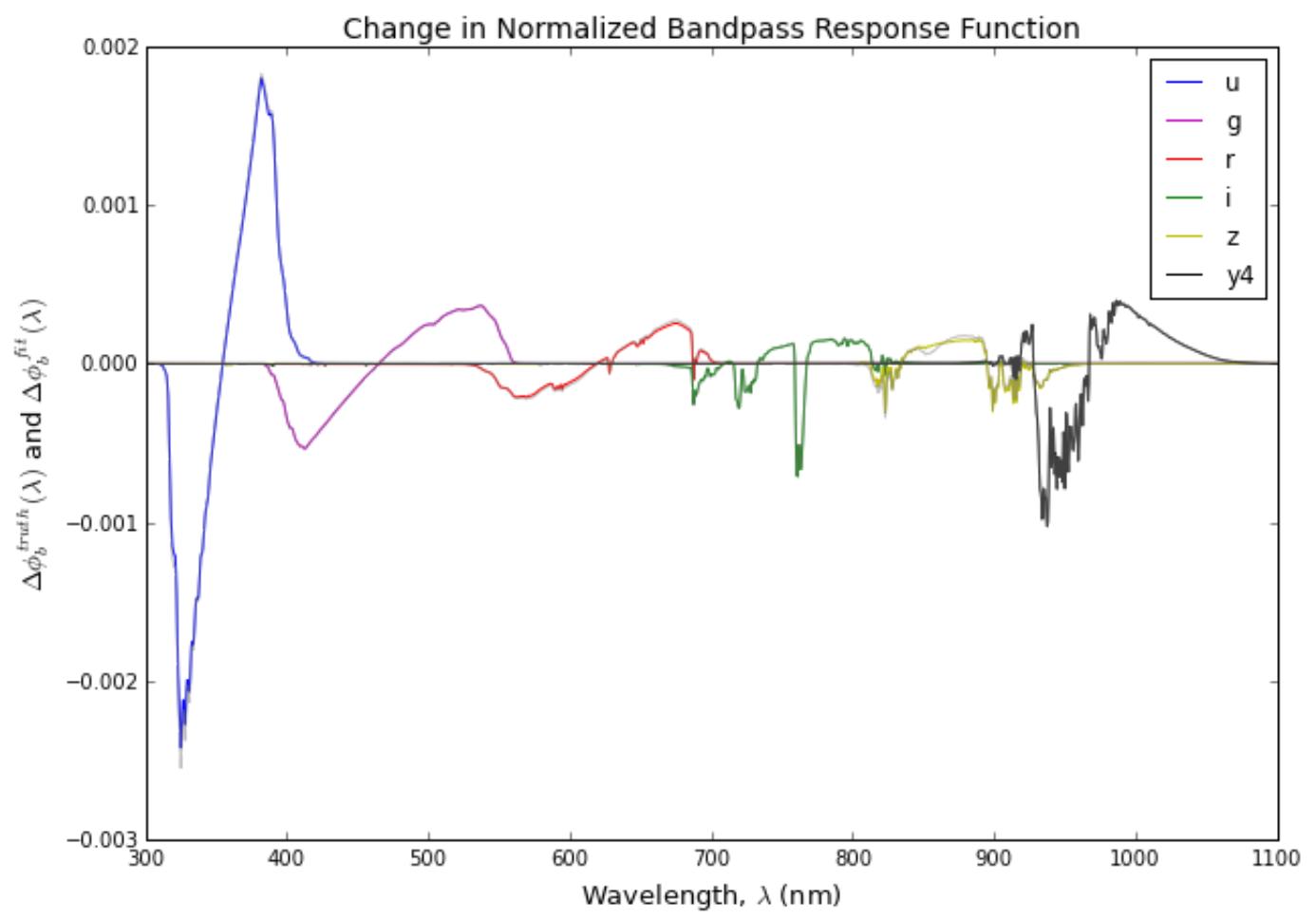
```

```
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: 988 Kurucz MS 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-2020_E5_mss_u_50dgb_50b_min_dGTest_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-2020_E5_mss_g_50dgb_50b_min_dGTest_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-2020_E5_mss_r_50dgb_50b_min_dGTest_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-2020_E5_mss_i_50dgb_50b_min_dGTest_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-2020_E5_mss_z_50dgb_50b_min_dGTest_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-2020_E5_mss_y4_50dgb_50b_min_dGTest_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 1.08 11.02 1.84529956913 3.69059913827  
g 0.98 11.84 0.333507316062 0.667014632123  
r 1.08 11.84 0.402694027115 0.80538805423  
i 1.18 11.84 0.511180313834 1.02236062767  
z 5.00 11.84 0.451472124398 0.902944248795  
y4 1.96 11.84 0.525220740898 1.0504414818  
  
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
```

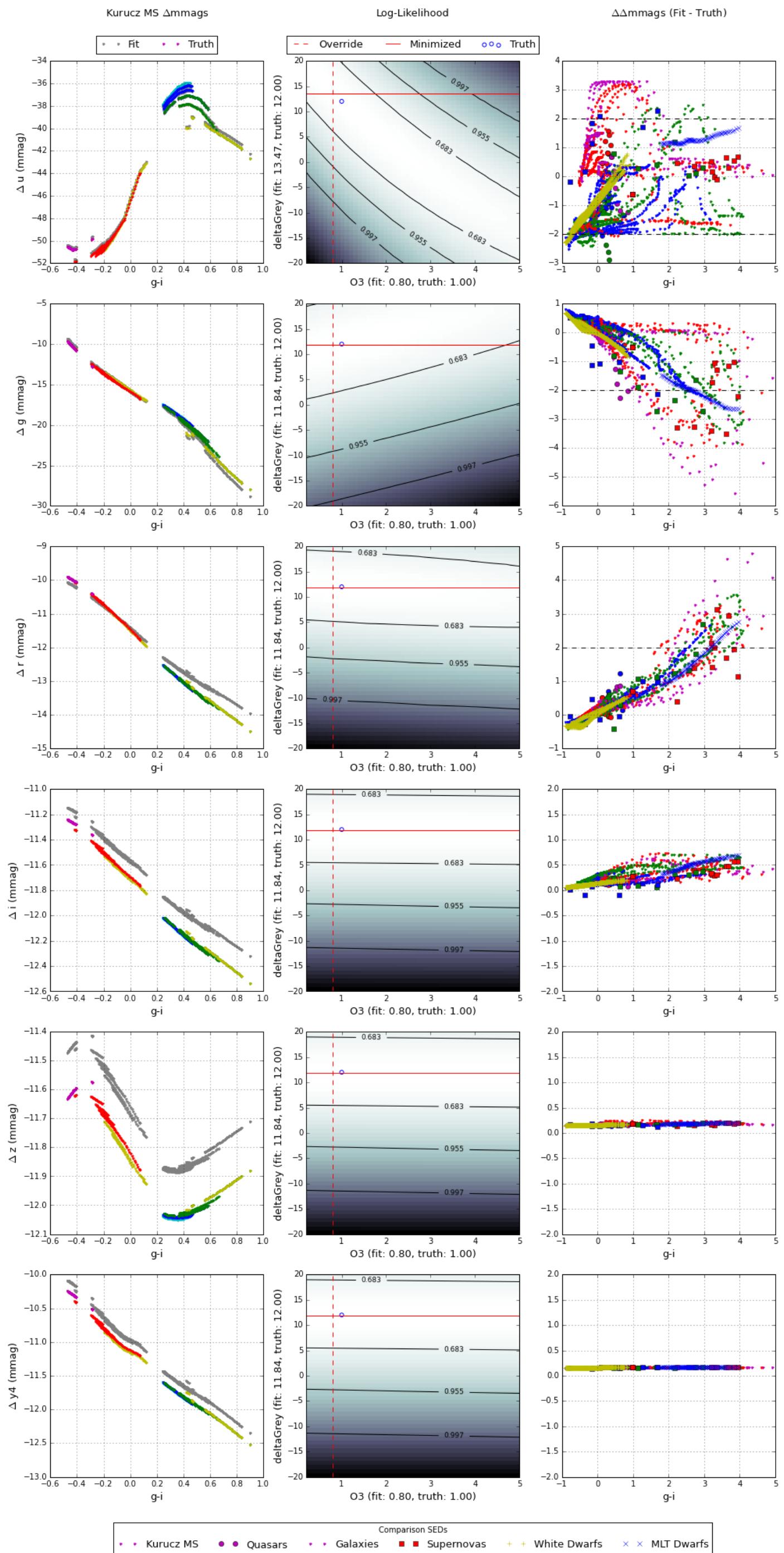


$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey}$ : 12.0)





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



Comparison SEDs					
• Kurucz MS	• Quasars	• Galaxies	■ Supernovas	+ White Dwarfs	× MLT Dwarfs

**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: 988 Kurucz MS 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_DG120_DGR-2020_E5_mss_u_51dgb_50b_max_dGTest_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_DG120_DGR-2020_E5_mss_g_51dgb_50b_max_dGTest_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_DG120_DGR-2020_E5_mss_r_51dgb_50b_max_dGTest_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_DG120_DGR-2020_E5_mss_i_51dgb_50b_max_dGTest_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_DG120_DGR-2020_E5_mss_z_51dgb_50b_max_dGTest_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_DG120_DGR-2020_E5_mss_y4_51dgb_50b_max_dGTest_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 2.10870885363 4.21741770725
g 0.98 12.00 1.28312684426 2.56625368853
r 0.98 12.00 0.0109776168985 0.021955233797
i 0.98 12.00 0.000392037446594 0.000784074893187
z 0.98 12.00 3.74027790738e-05 7.48055581475e-05
y4 0.98 12.00 3.62197249874e-05 7.24394499748e-05

Override best fit parameters (Filter, Rayleigh, dG):
u 1.20 -0.80
g 1.20 9.60
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: 988 Kurucz MS 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_DGR-2020_E5_mss_u_51dgb_50b_min_dGTest_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_DGR-2020_E5_mss_g_51dgb_50b_min_dGTest_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_DGR-2020_E5_mss_r_51dgb_50b_min_dGTest_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_DGR-2020_E5_mss_i_51dgb_50b_min_dGTest_OR80.pkl'
Saved LogL at best fit deltaGrey for i filter.
Saved Chi-Squared at best fit deltaGrey for i filter.
Completed i filter.

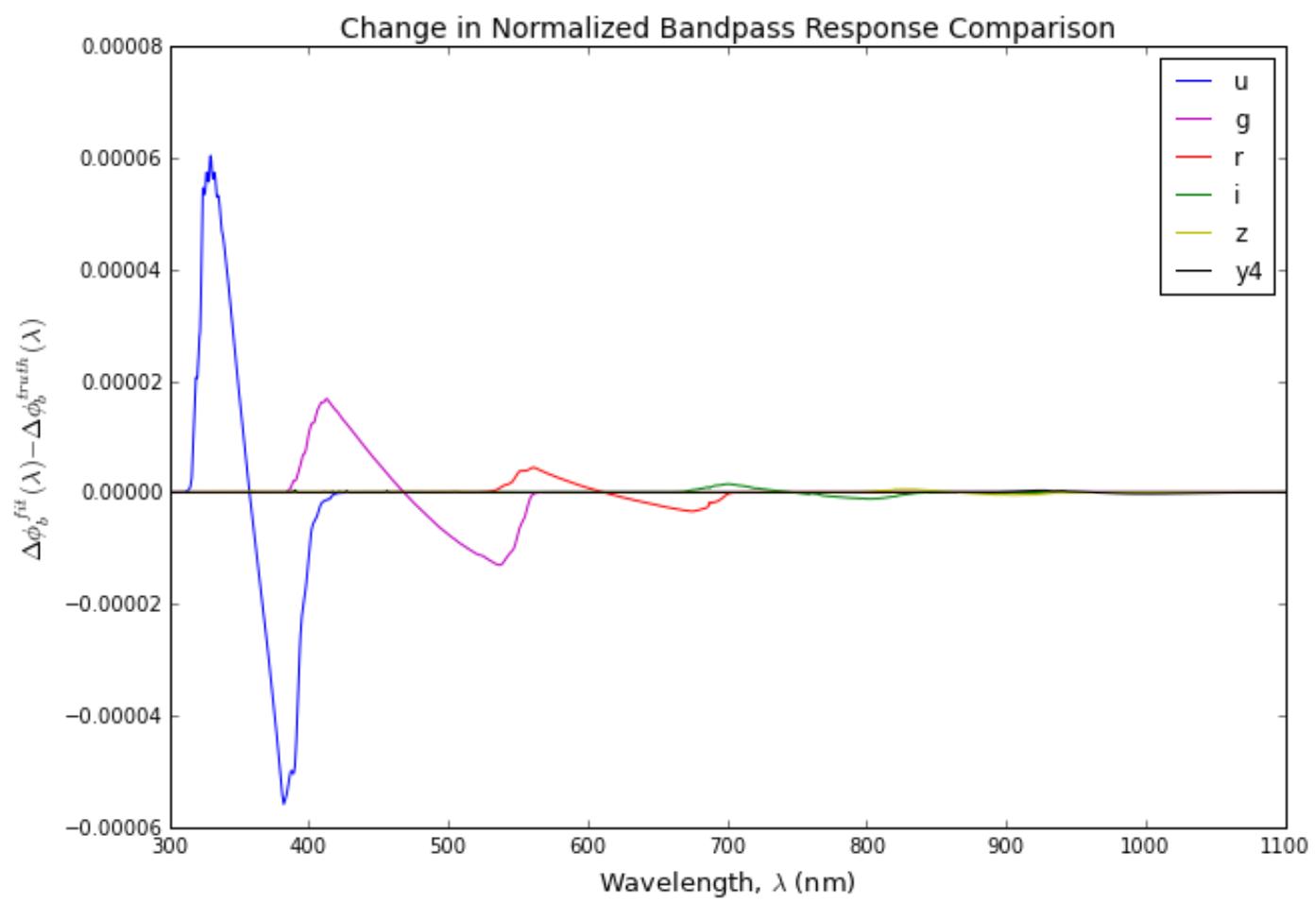
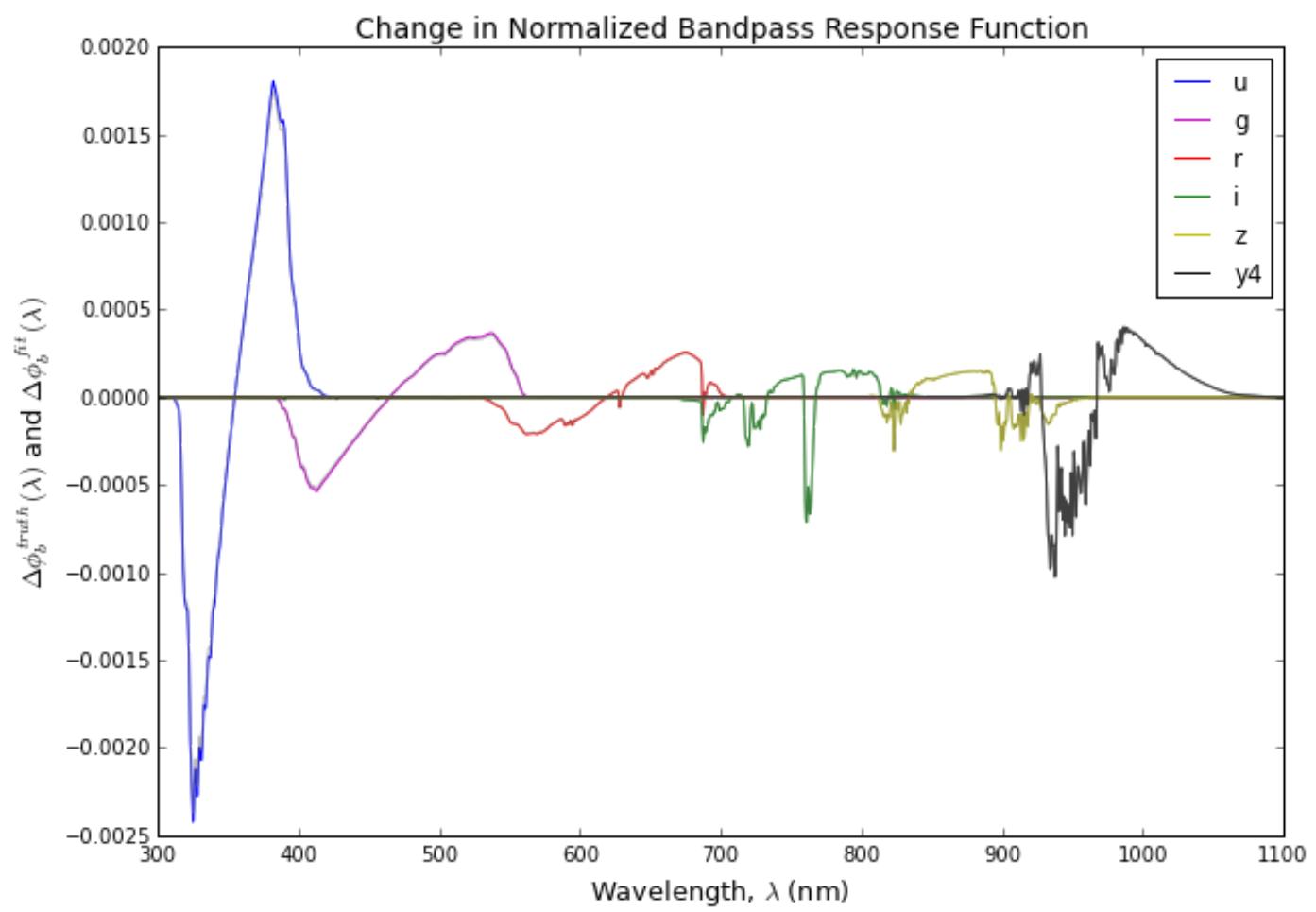
Calculating best fit parameters for z filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Rayleigh_dG_XSTD12_DGR-2020_E5_mss_z_51dgb_50b_min_dGTest_OR80.pkl'
Saved LogL at best fit deltaGrey for z filter.
Saved Chi-Squared at best fit deltaGrey for z filter.
Completed z filter.

Calculating best fit parameters for y4 filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Rayleigh_dG_XSTD12_DGR-2020_E5_mss_y4_51dgb_50b_min_dGTest_OR80.pkl'
Saved LogL at best fit deltaGrey for y4 filter.
Saved Chi-Squared at best fit deltaGrey for y4 filter.
Completed y4 filter.

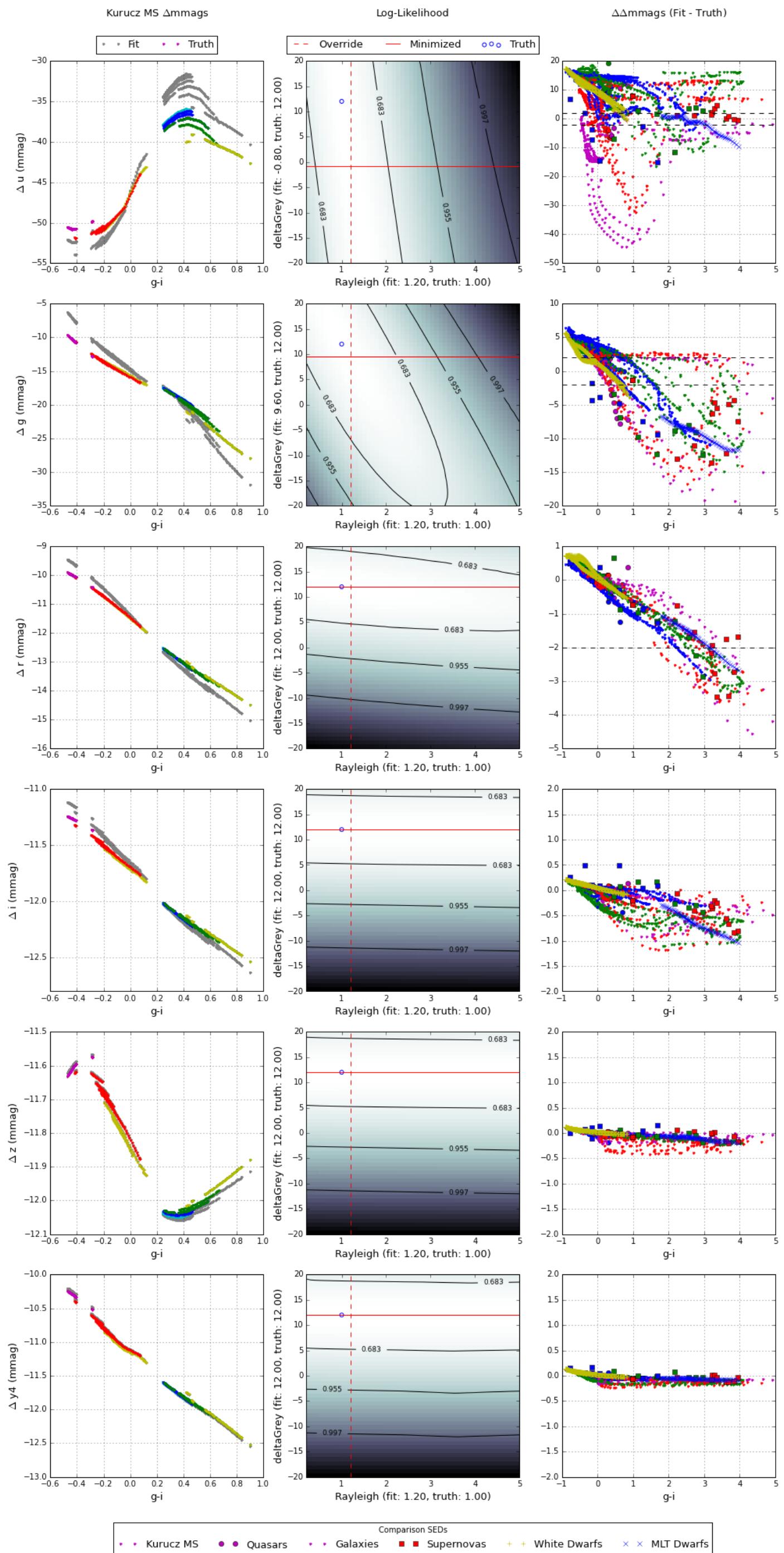
Best fit parameters (Filter, Rayleigh, dG, logL, Chi-Squared):
u 0.98 12.80 2.10870885363 4.21741770725
g 0.98 12.00 1.28312684426 2.56625368853
r 0.98 12.00 0.0109776168985 0.021955233797
i 0.98 12.00 0.000392037446594 0.000784074893187
z 0.98 12.00 3.74027790738e-05 7.48055581475e-05
y4 0.98 12.00 3.62197249874e-05 7.24394499748e-05

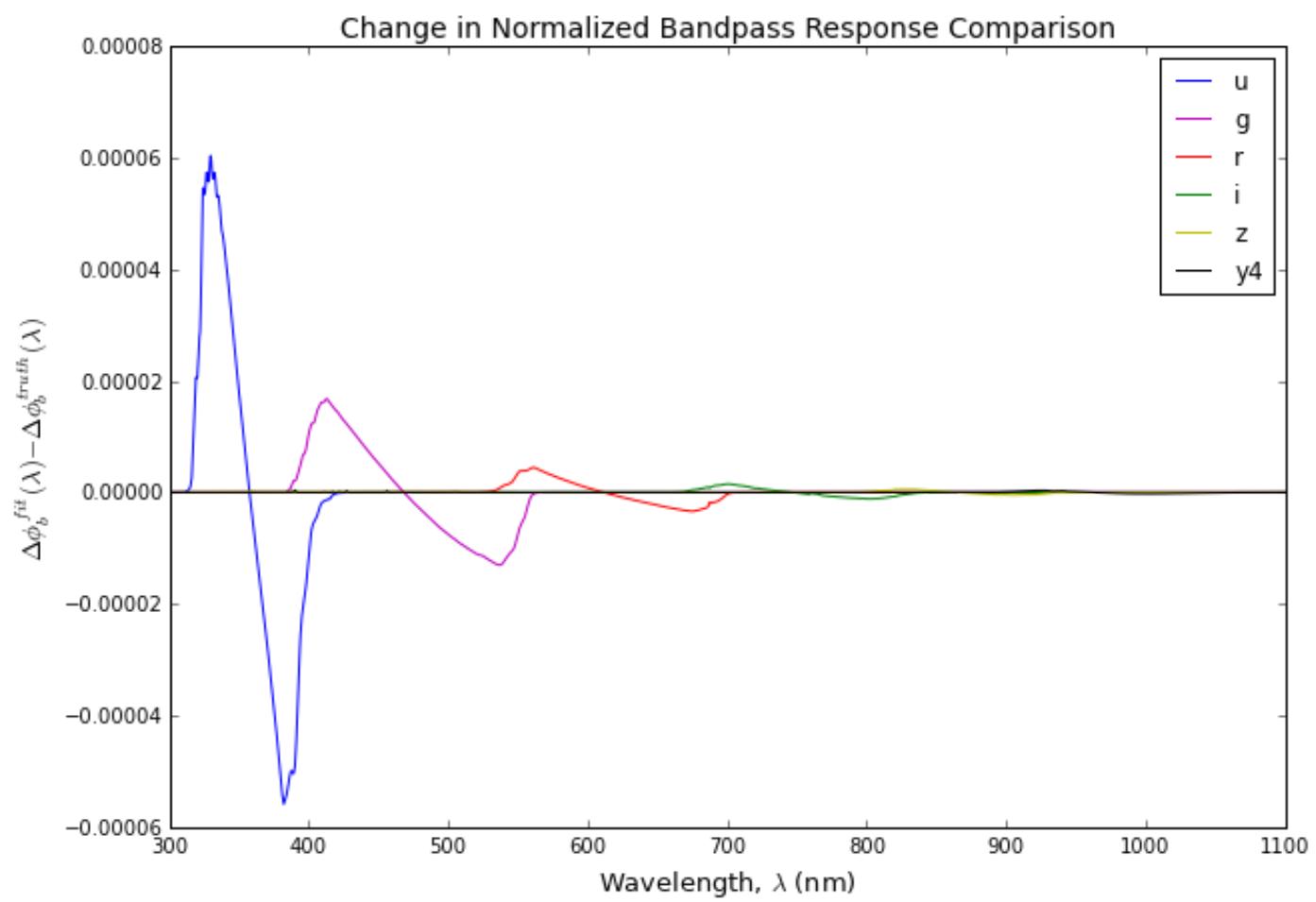
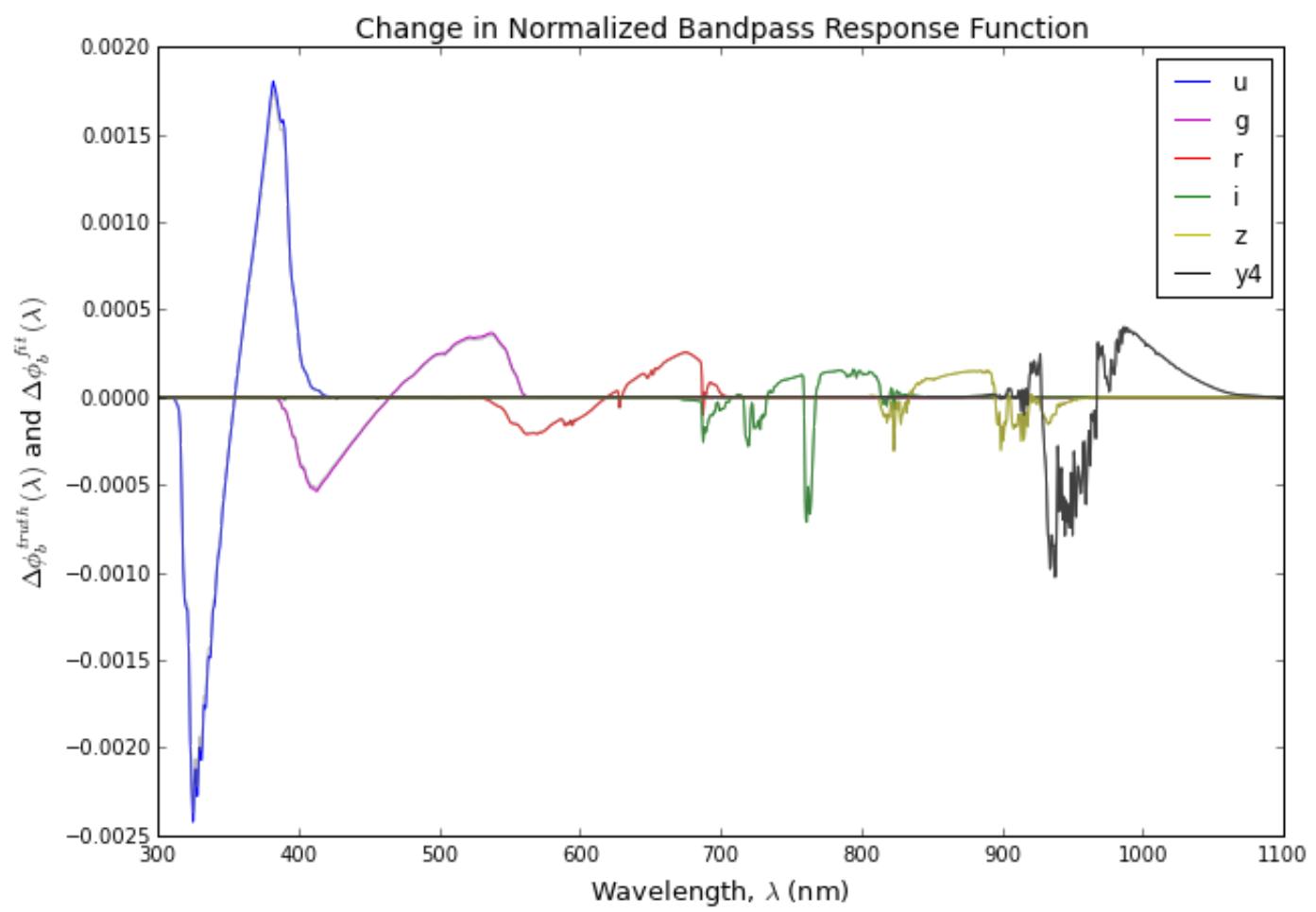
Override best fit parameters (Filter, Rayleigh, dG):
u 0.80 20.00
g 0.80 14.40
r 0.80 12.00
i 0.80 12.00
z 0.80 12.00
y4 0.80 12.00

```

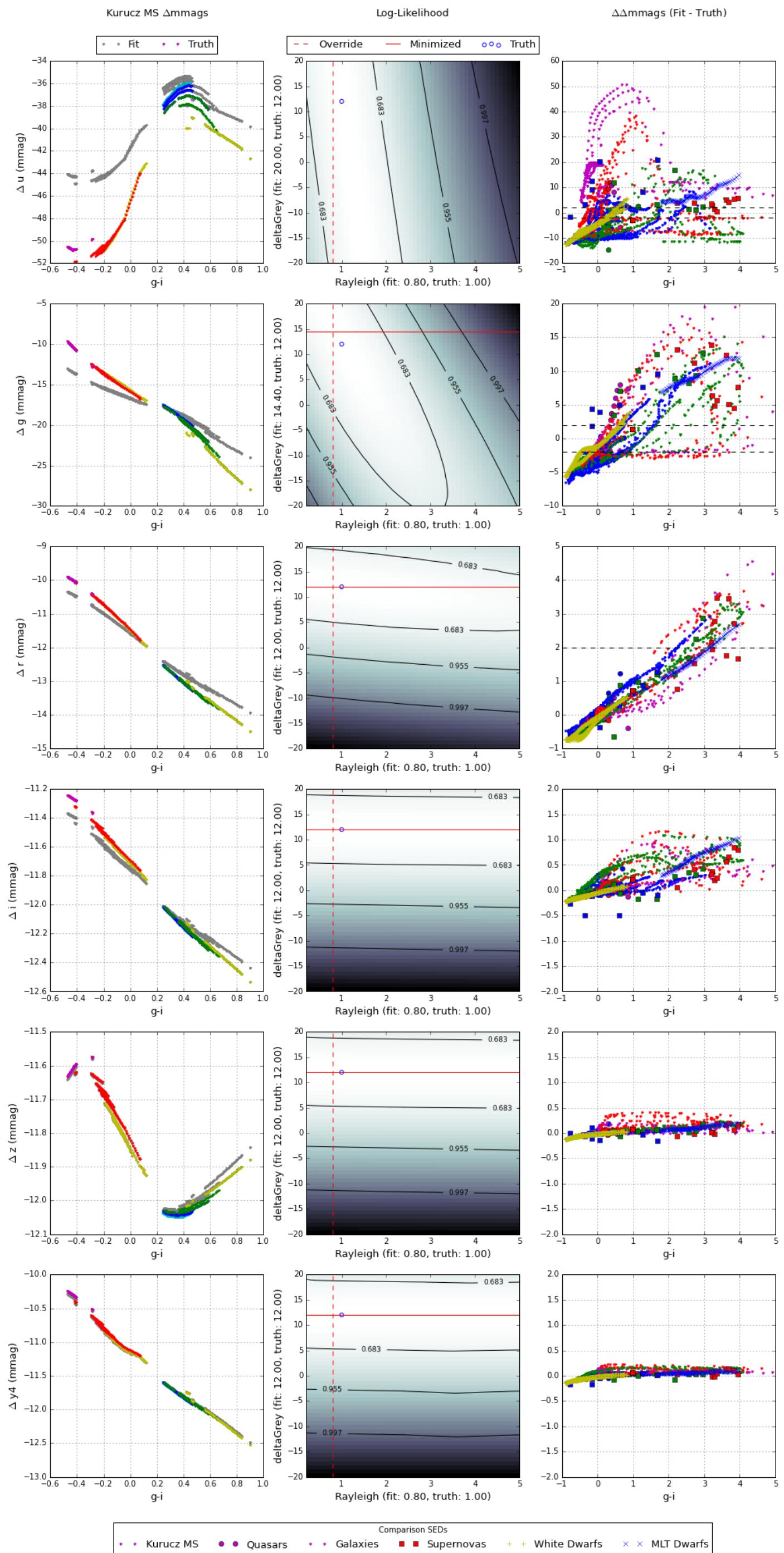


$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey}: 12.0$ )





$\Delta\text{mmags}$ , 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: 988 Kurucz MS 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_DG120_DGR-2020_E5_mss_u_50dgb_50b_max_dGTest_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_DG120_DGR-2020_E5_mss_g_50dgb_50b_max_dGTest_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_DG120_DGR-2020_E5_mss_r_50dgb_50b_max_dGTest_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_DG120_DGR-2020_E5_mss_i_50dgb_50b_max_dGTest_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_DG120_DGR-2020_E5_mss_z_50dgb_50b_max_dGTest_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_DG120_DGR-2020_E5_mss_y4_50dgb_50b_max_dGTest_OR120.pkl'
Saved LogL at best fit deltaGrey for y4 filter.
Saved Chi-Squared at best fit deltaGrey for y4 filter.
Completed y4 filter.

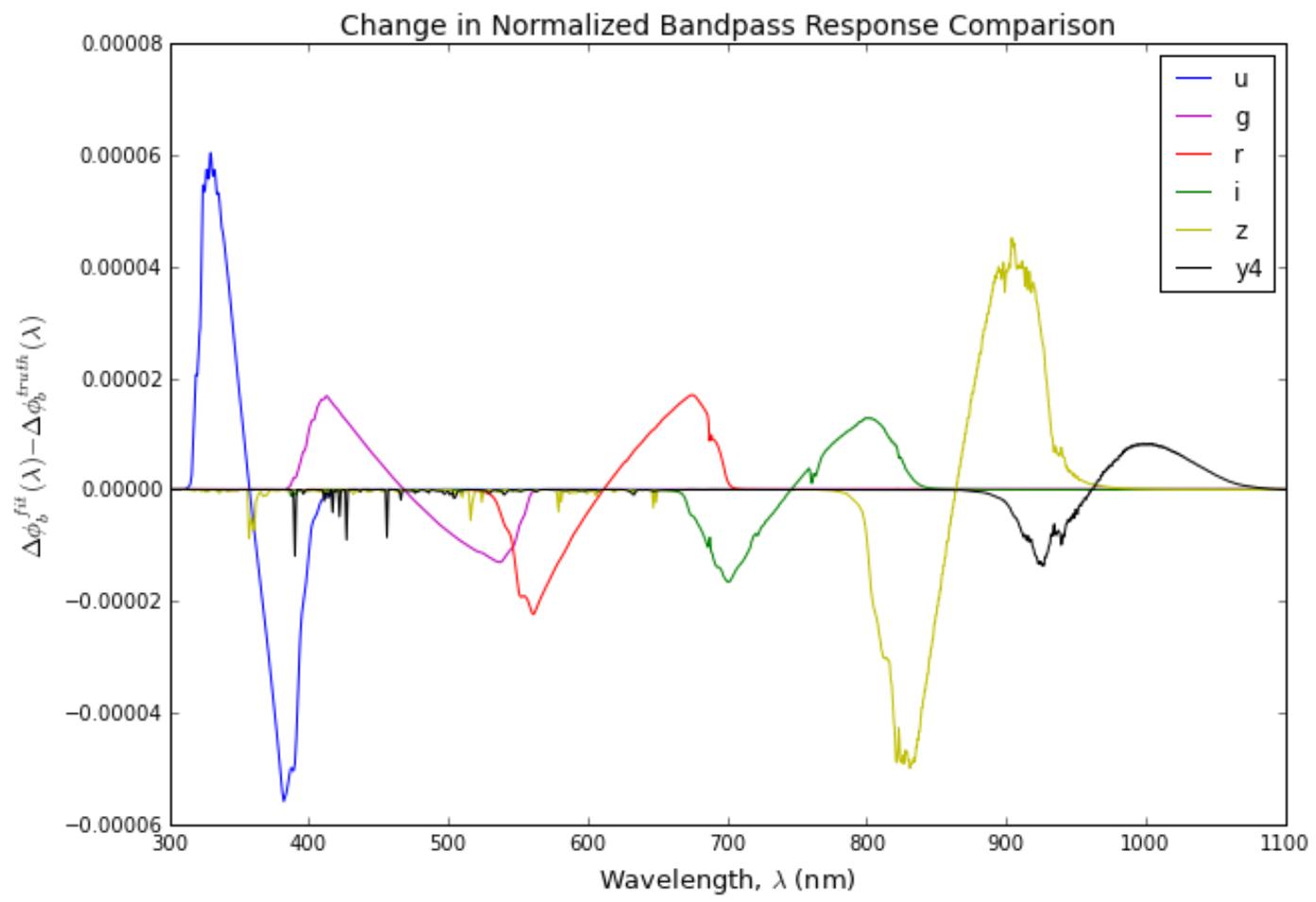
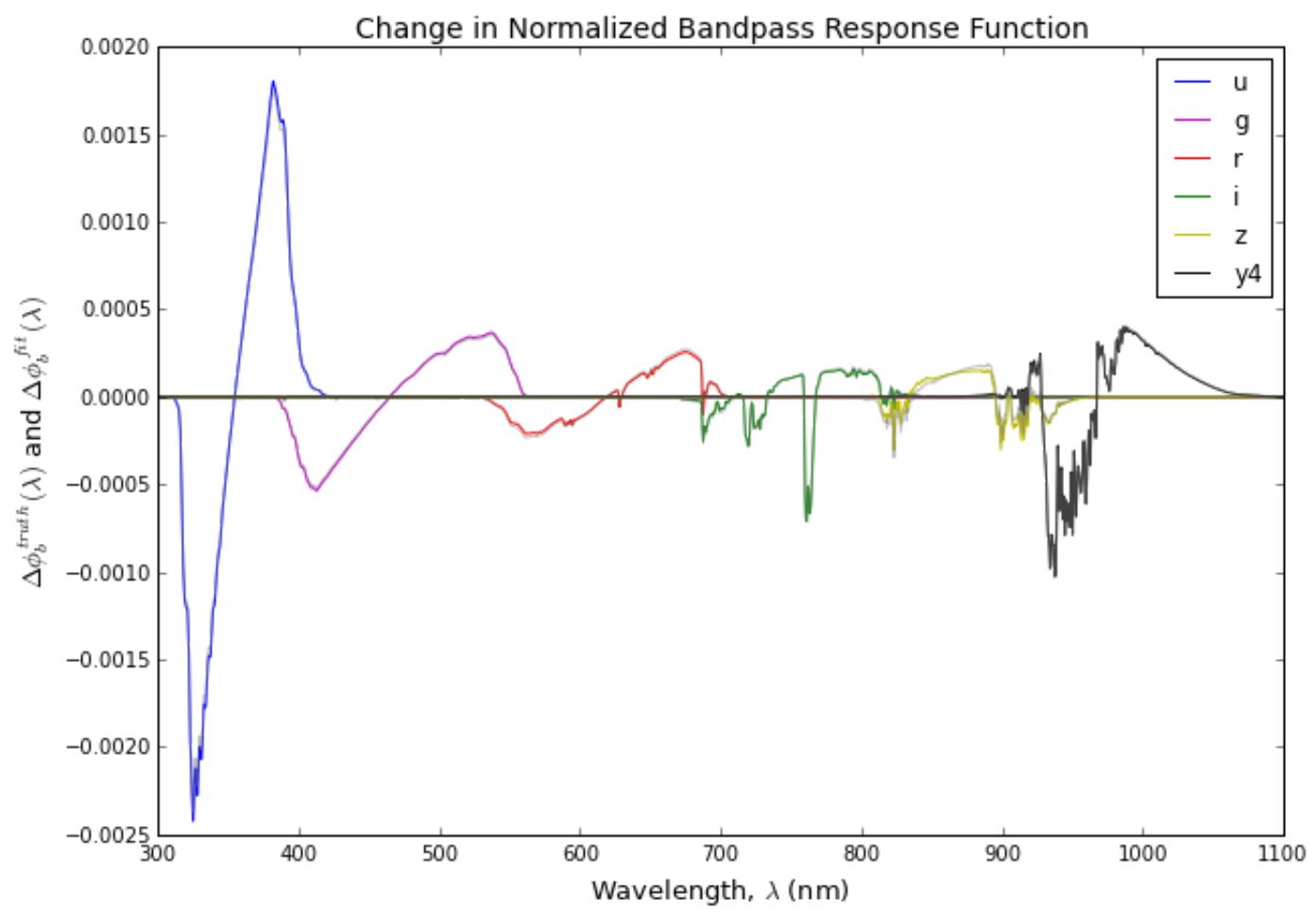
Best fit parameters (Filter, Rayleigh, dG, logL, Chi-Squared):
u 0.98 12.65 3.8629109225 7.72582184501
g 0.98 11.84 3.25538253381 6.51076506762
r 1.08 11.84 0.365512213491 0.731024426981
i 1.18 11.84 0.496553235262 0.993106470524
z 2.45 11.84 0.291188929943 0.582377859885
y4 1.57 11.84 0.477730078396 0.955460156793

Override best fit parameters (Filter, Rayleigh, dG):
u 1.20 -0.41
g 1.20 9.39
r 1.20 11.84
i 1.20 11.84
z 1.20 11.84
y4 1.20 11.84

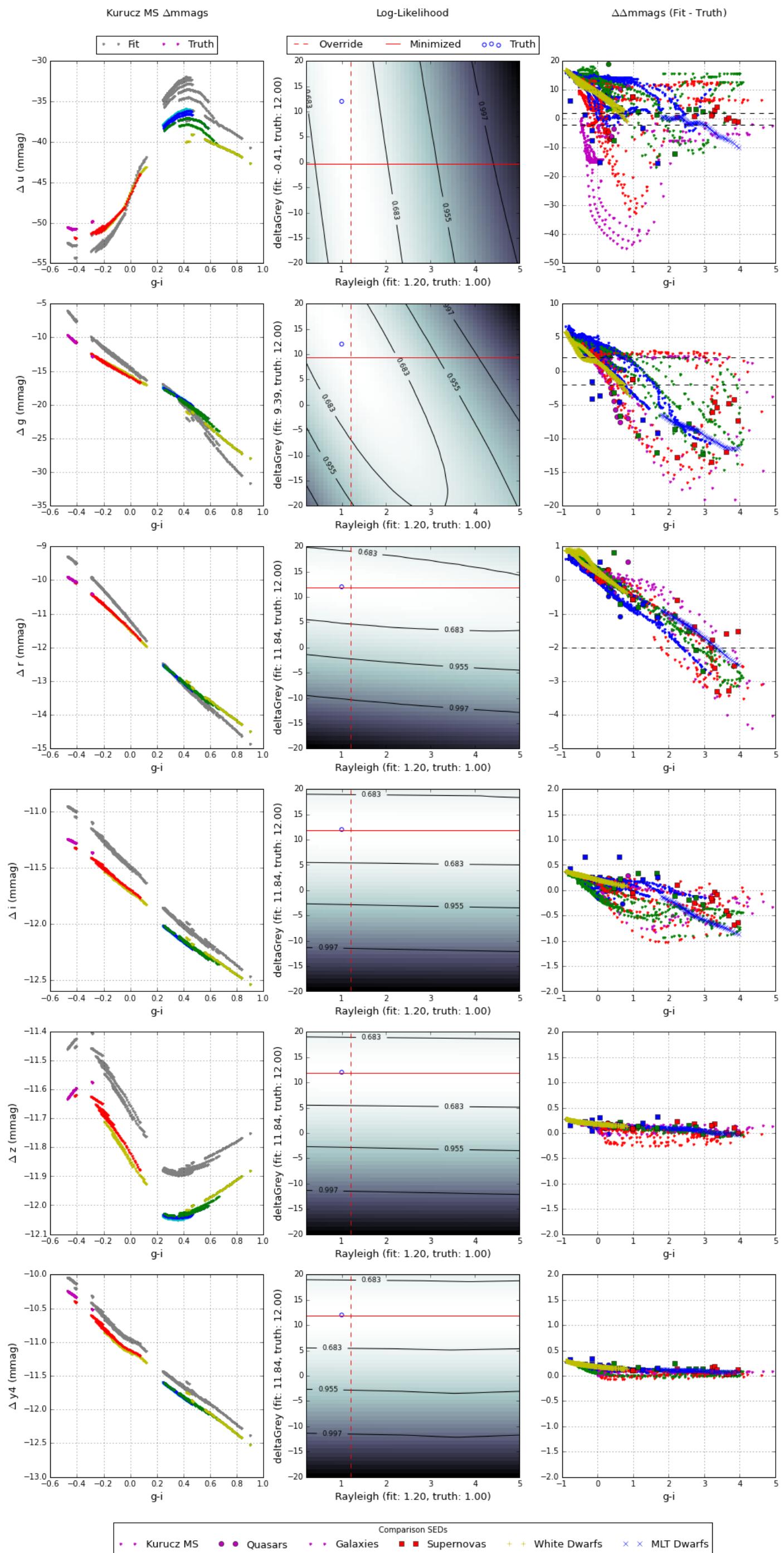
Computing nonlinear regression for Rayleigh.
Observed atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]
Observed atmosphere airmass: 2.0
Standard atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]
Standard atmosphere airmass: 1.2
Observed atmosphere parameter for Rayleigh: 1.0

```

```
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: 988 Kurucz MS 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_DGR-2020_E5_mss_u_50dgb_50b_min_dGTest_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_DGR-2020_E5_mss_g_50dgb_50b_min_dGTest_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_DGR-2020_E5_mss_r_50dgb_50b_min_dGTest_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_DGR-2020_E5_mss_i_50dgb_50b_min_dGTest_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_DGR-2020_E5_mss_z_50dgb_50b_min_dGTest_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_DGR-2020_E5_mss_y4_50dgb_50b_min_dGTest_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 3.8629109225 7.72582184501  
g 0.98 11.84 3.25538253381 6.51076506762  
r 1.08 11.84 0.365512213491 0.731024426981  
i 1.18 11.84 0.496553235262 0.993106470524  
z 2.45 11.84 0.291188929943 0.582377859885  
y4 1.57 11.84 0.477730078396 0.955460156793  
  
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
```

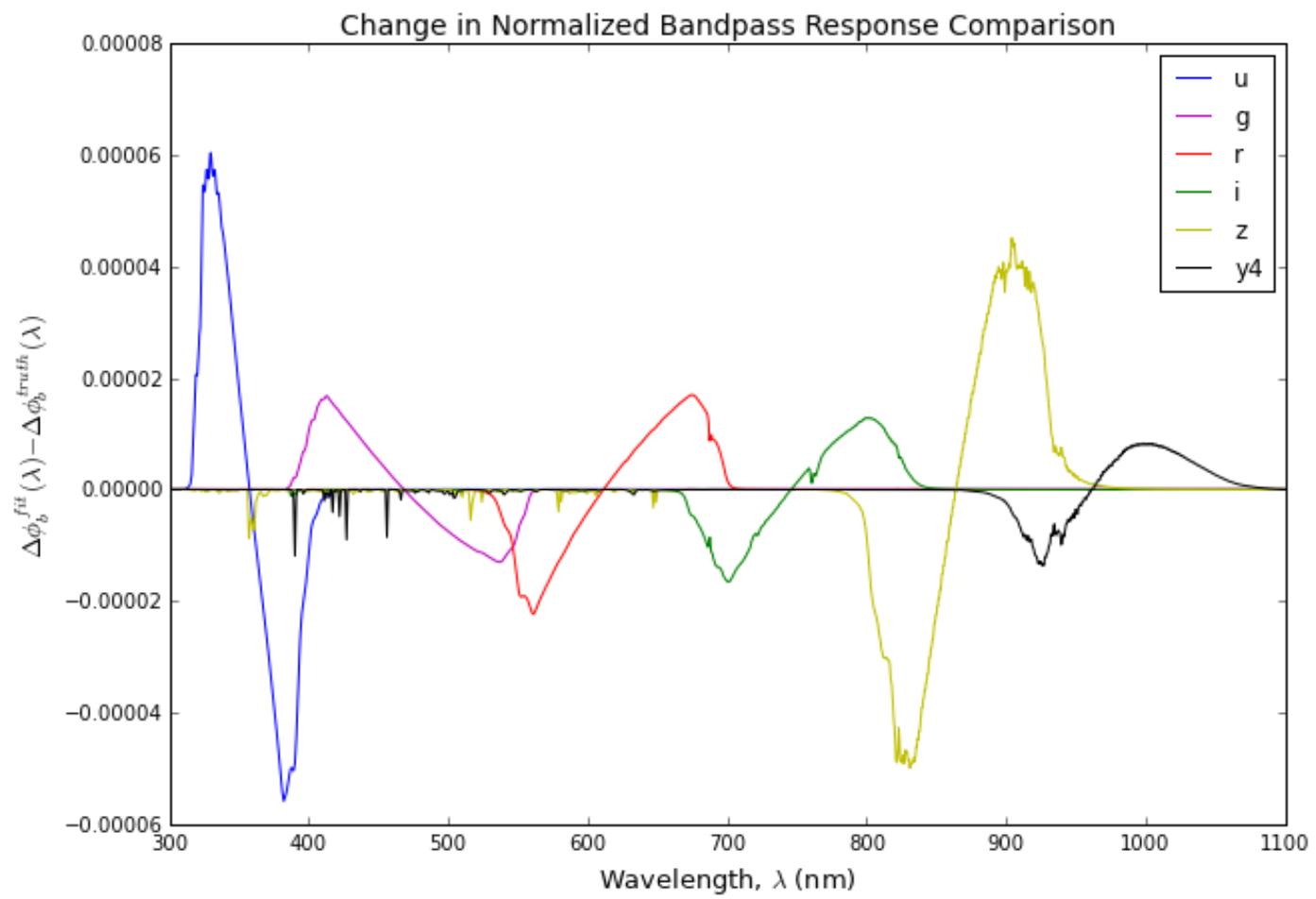
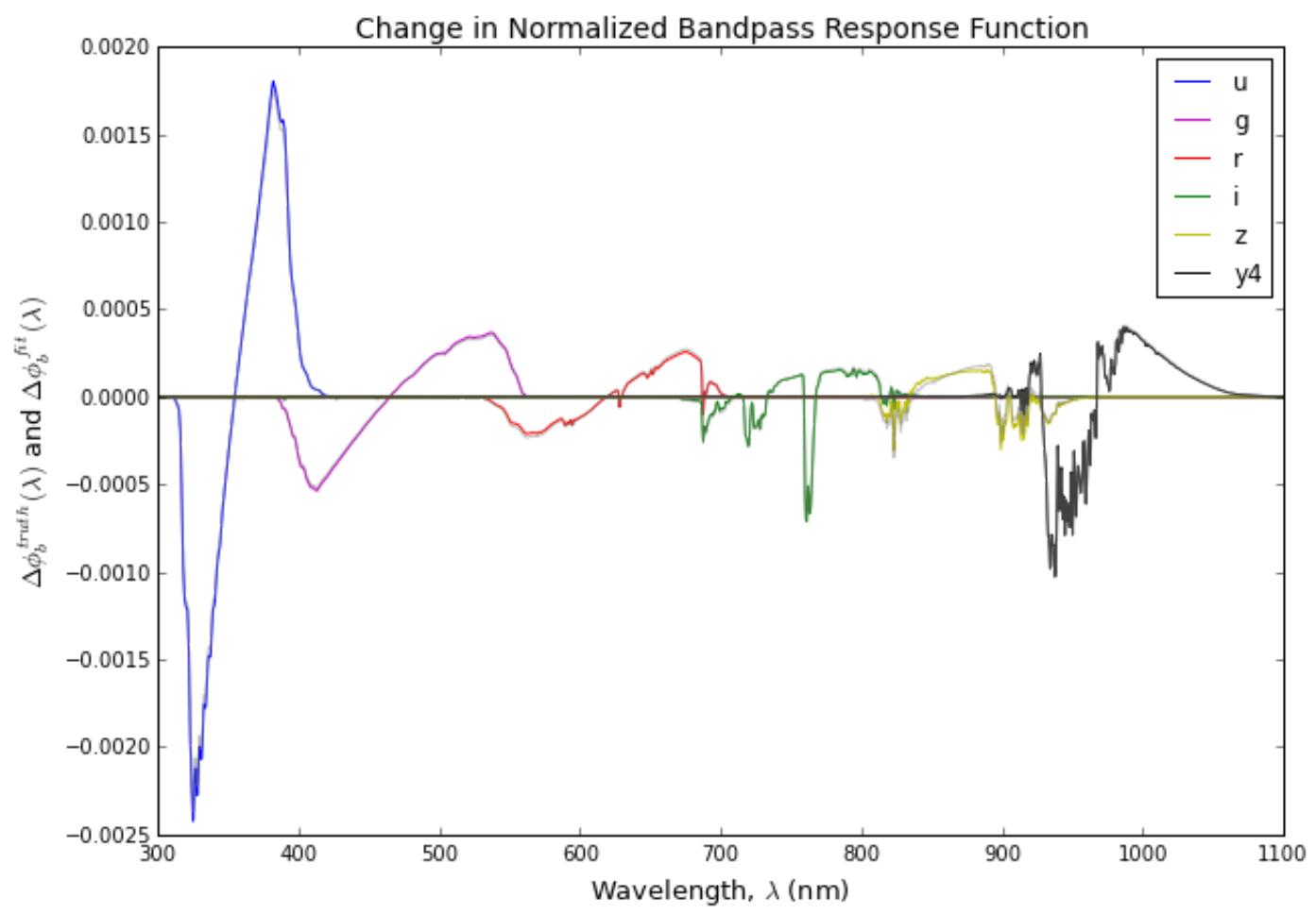


$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey}: 12.0$ )

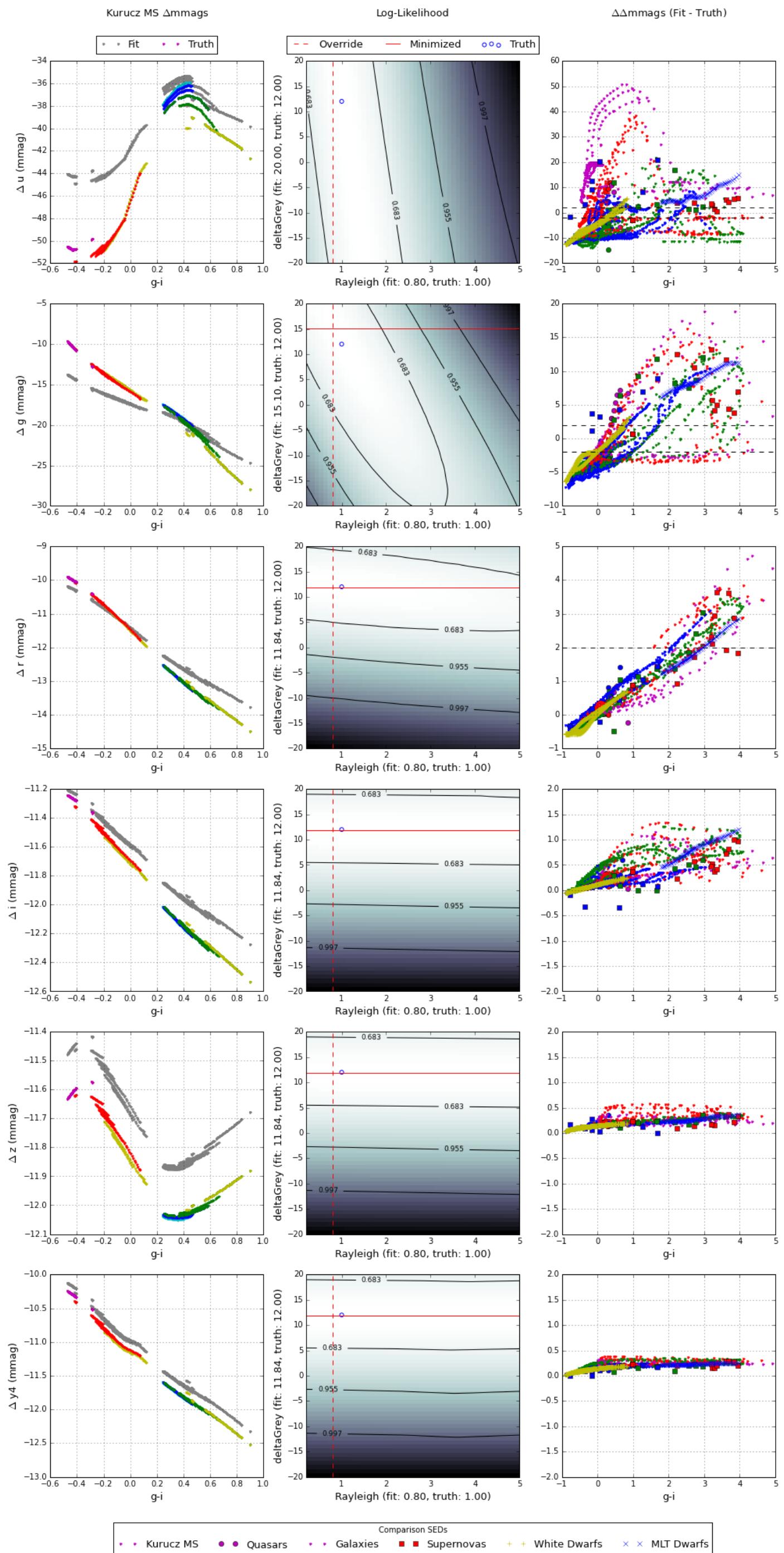


Comparison SEDs

• Kurucz MS	• Quasars	• Galaxies	■ Supernovas	+ White Dwarfs	× MLT Dwarfs
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$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey}: 12.0$ )



Comparison SEDs

## **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: 988 Kurucz MS 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_DG120_DGR-2020_E5_mss_u_51dgb_50b_max_dGTest_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_DG120_DGR-2020_E5_mss_g_51dgb_50b_max_dGTest_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_DG120_DGR-2020_E5_mss_r_51dgb_50b_max_dGTest_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_DG120_DGR-2020_E5_mss_i_51dgb_50b_max_dGTest_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_DG120_DGR-2020_E5_mss_z_51dgb_50b_max_dGTest_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_DG120_DGR-2020_E5_mss_y4_51dgb_50b_max_dGTest_OR120.pkl'
Saved LogL at best fit deltaGrey for y4 filter.
Saved Chi-Squared at best fit deltaGrey for y4 filter.
Completed y4 filter.

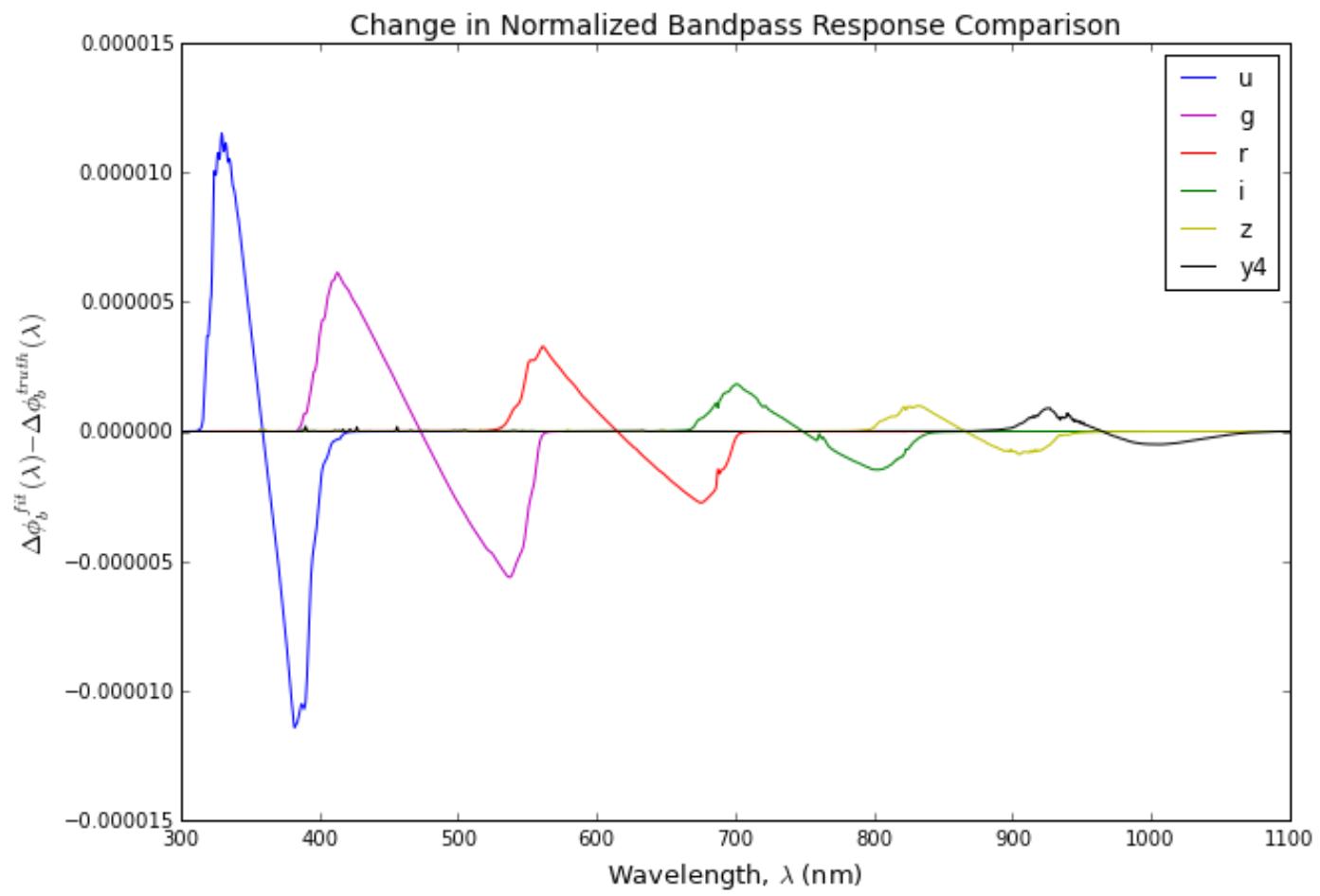
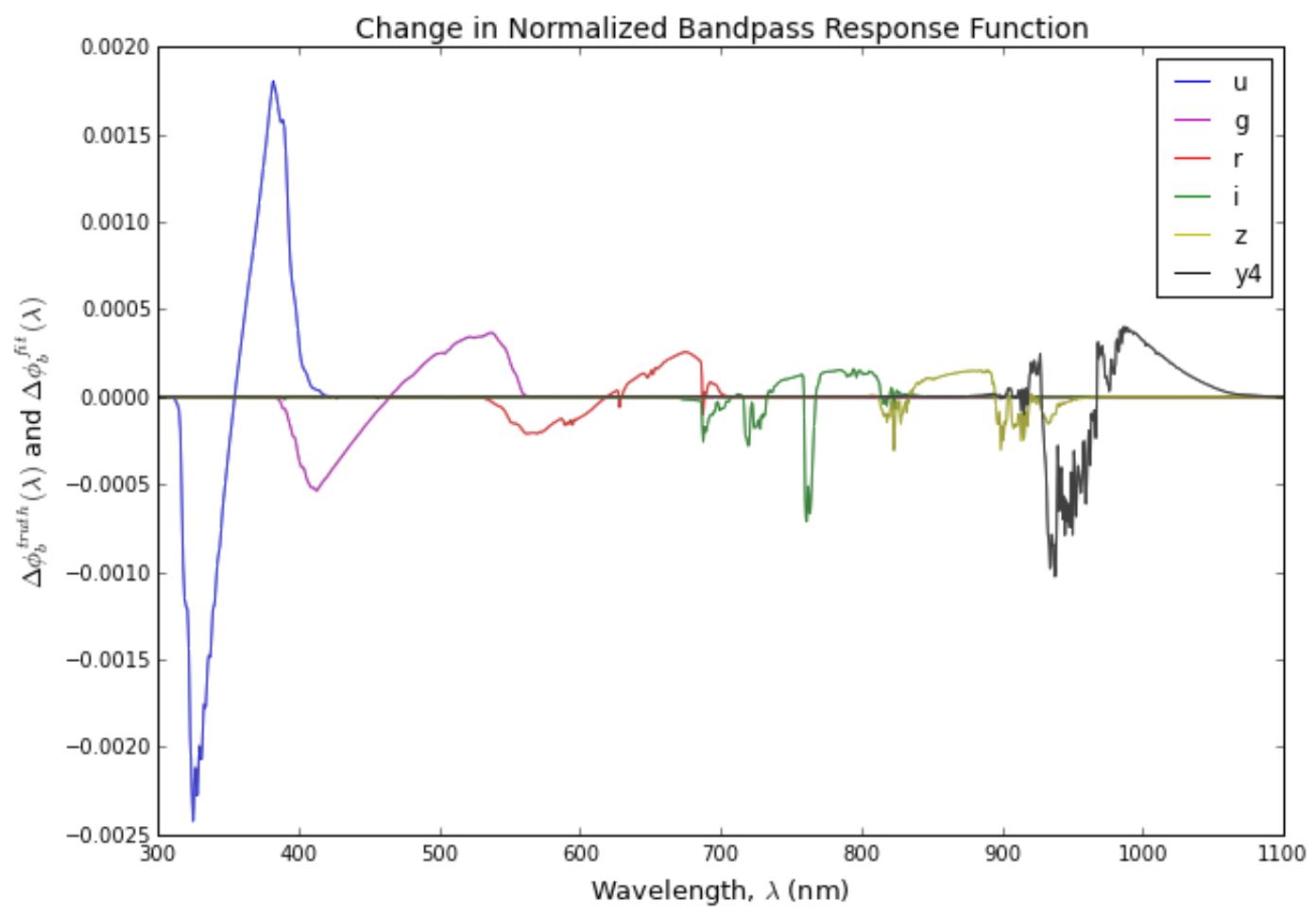
Best fit parameters (Filter, Aerosol, dG, logL, Chi-Squared):
u 0.98 12.00 0.919864685368 1.83972937074
g 0.98 12.00 0.19712864504 0.394257290081
r 0.98 12.00 0.00635615720054 0.0127123144011
i 0.98 12.00 0.000546585397112 0.00109317079422
z 0.98 12.00 3.3657384444e-05 6.7314768888e-05
y4 0.98 12.00 4.31307528454e-05 8.62615056908e-05

Override best fit parameters (Filter, Aerosol, dG):
u 1.20 9.60
g 1.20 11.20
r 1.20 12.00
i 1.20 12.00
z 1.20 12.00
y4 1.20 12.00

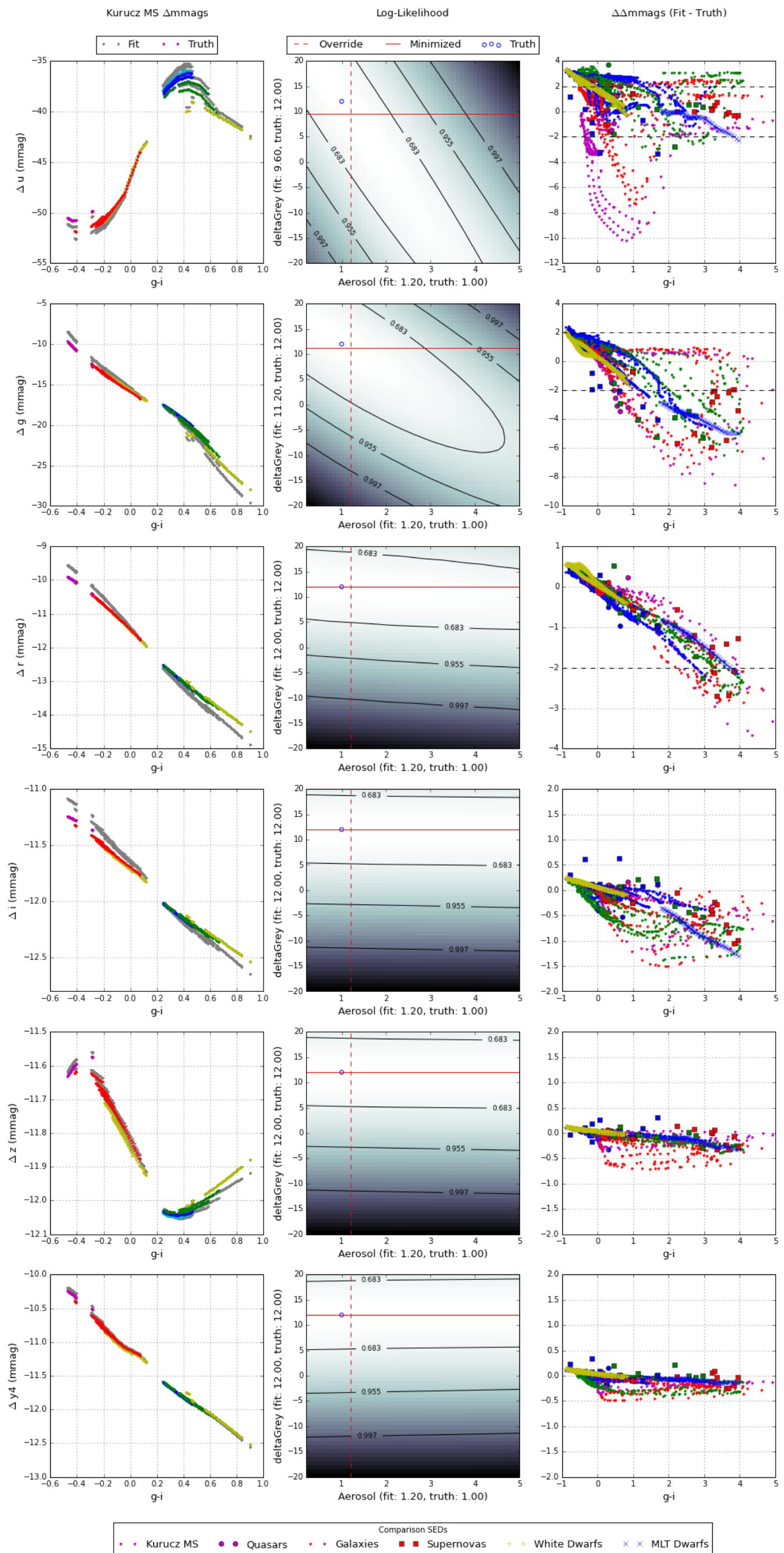
Computing nonlinear regression for Aerosol.
Observed atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]
Observed atmosphere airmass: 2.0
Standard atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]
Standard atmosphere airmass: 1.2
Observed atmosphere parameter for Aerosol: 1.0

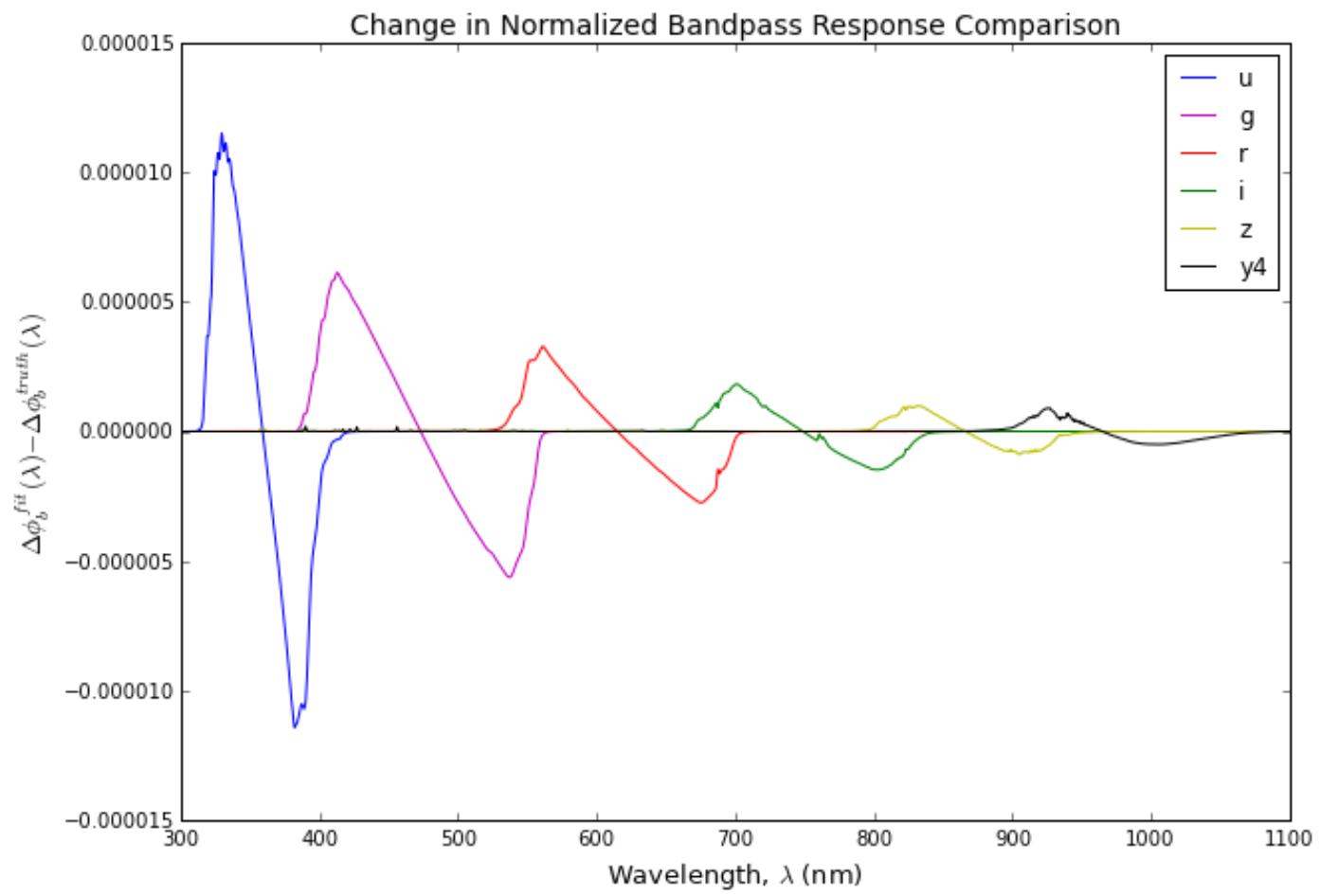
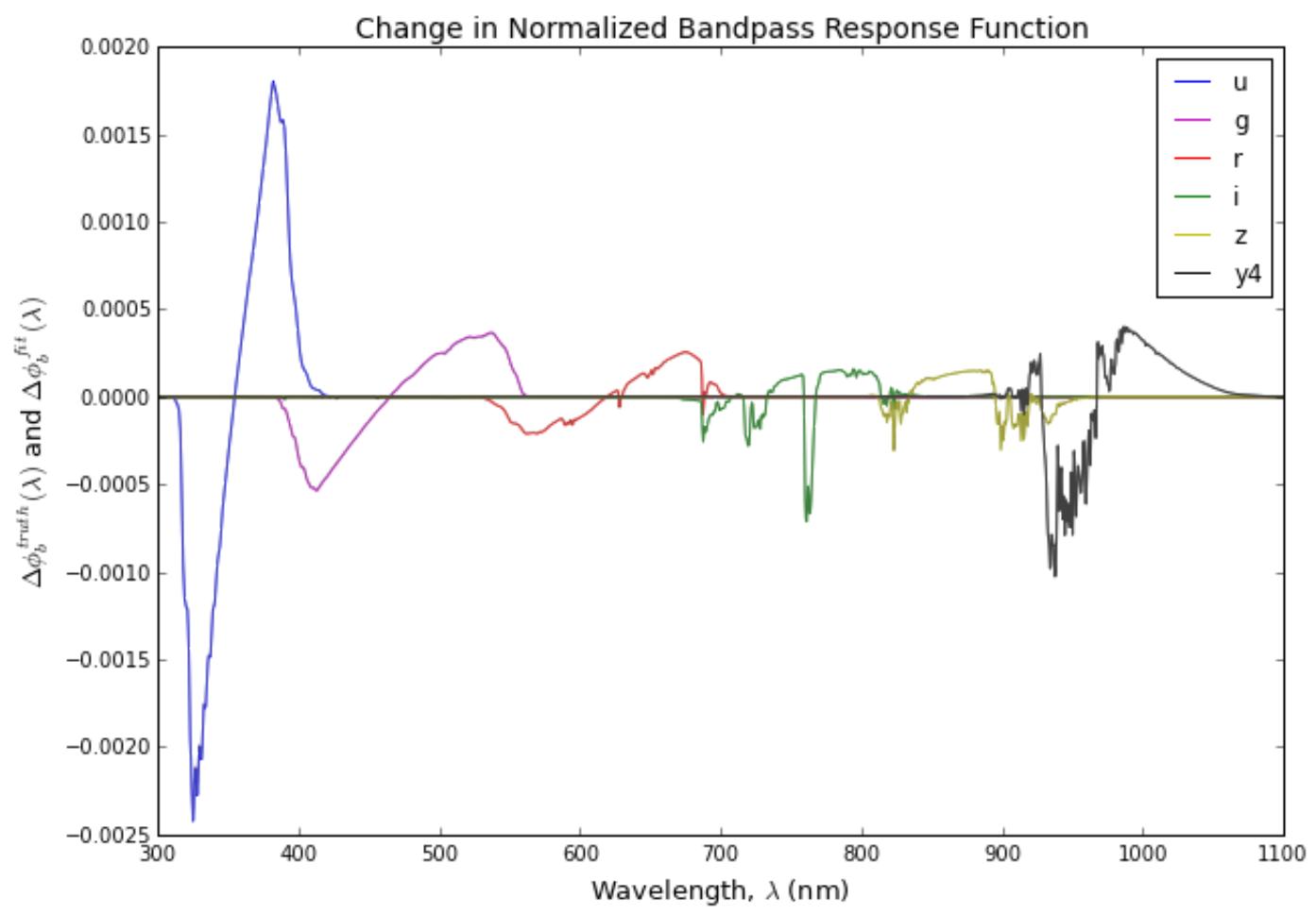
```

```
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: 988 Kurucz MS 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_DG120_DGR-2020_E5_mss_u_51dgb_50b_min_dGTest_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_DG120_DGR-2020_E5_mss_g_51dgb_50b_min_dGTest_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_DG120_DGR-2020_E5_mss_r_51dgb_50b_min_dGTest_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_DG120_DGR-2020_E5_mss_i_51dgb_50b_min_dGTest_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_DG120_DGR-2020_E5_mss_z_51dgb_50b_min_dGTest_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_DG120_DGR-2020_E5_mss_y4_51dgb_50b_min_dGTest_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 0.919864685368 1.83972937074  
g 0.98 12.00 0.19712864504 0.394257290081  
r 0.98 12.00 0.00635615720054 0.0127123144011  
i 0.98 12.00 0.000546585397112 0.00109317079422  
z 0.98 12.00 3.3657384444e-05 6.7314768888e-05  
y4 0.98 12.00 4.31307528454e-05 8.62615056908e-05  
  
Override best fit parameters (Filter, Aerosol, dG):  
u 0.80 14.40  
g 0.80 12.80  
r 0.80 12.00  
i 0.80 12.00  
z 0.80 12.00  
y4 0.80 12.00
```

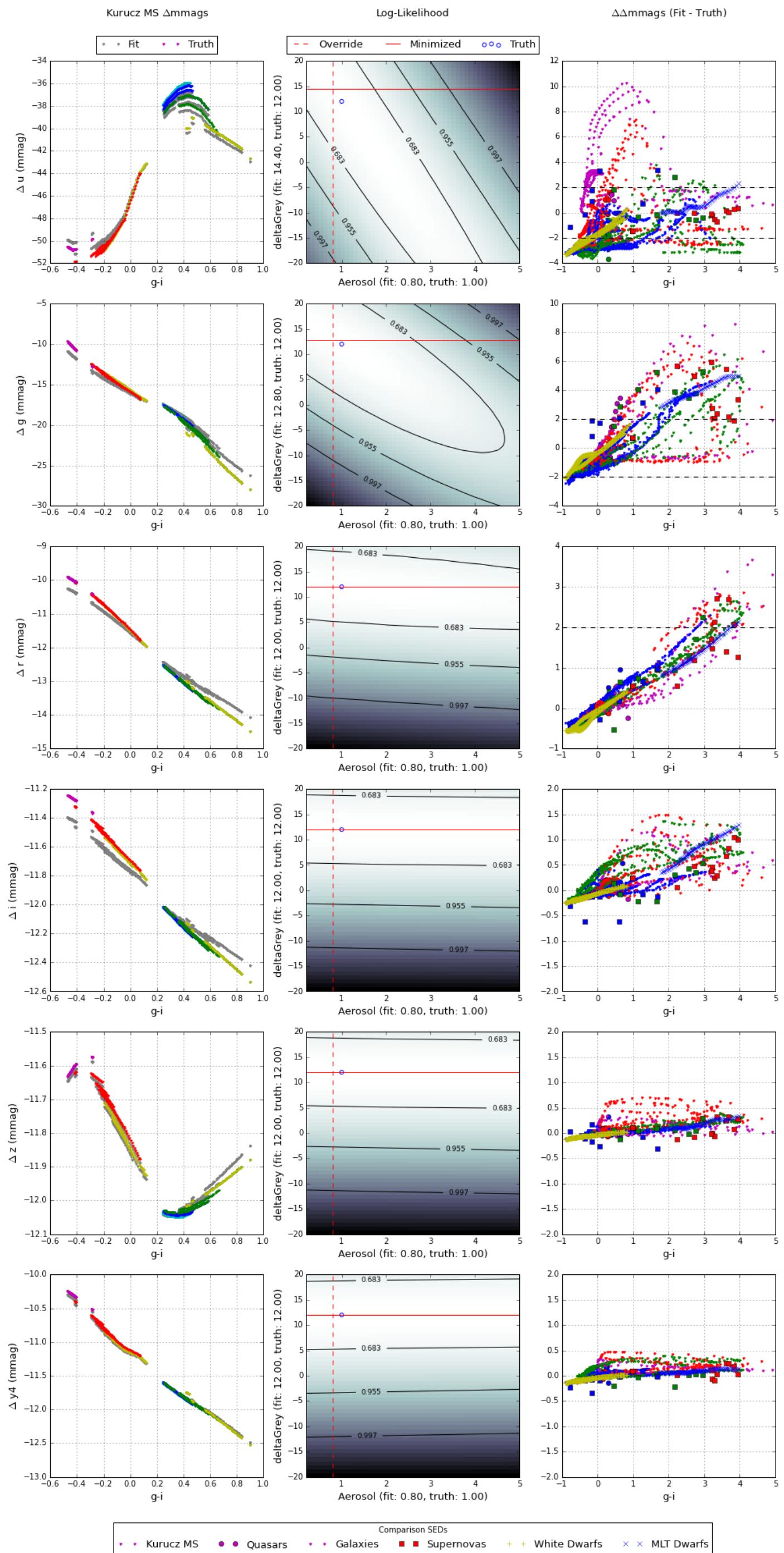


$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey}: 12.0$ )





$\Delta\text{mmags}$ , 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: 988 Kurucz MS 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_DG120_DGR-2020_E5_mss_u_50dgb_50b_max_dGTest_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_DG120_DGR-2020_E5_mss_g_50dgb_50b_max_dGTest_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_DG120_DGR-2020_E5_mss_r_50dgb_50b_max_dGTest_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_DG120_DGR-2020_E5_mss_i_50dgb_50b_max_dGTest_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_DG120_DGR-2020_E5_mss_z_50dgb_50b_max_dGTest_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_DG120_DGR-2020_E5_mss_y4_50dgb_50b_max_dGTest_OR120.pkl'
Saved LogL at best fit deltaGrey for y4 filter.
Saved Chi-Squared at best fit deltaGrey for y4 filter.
Completed y4 filter.

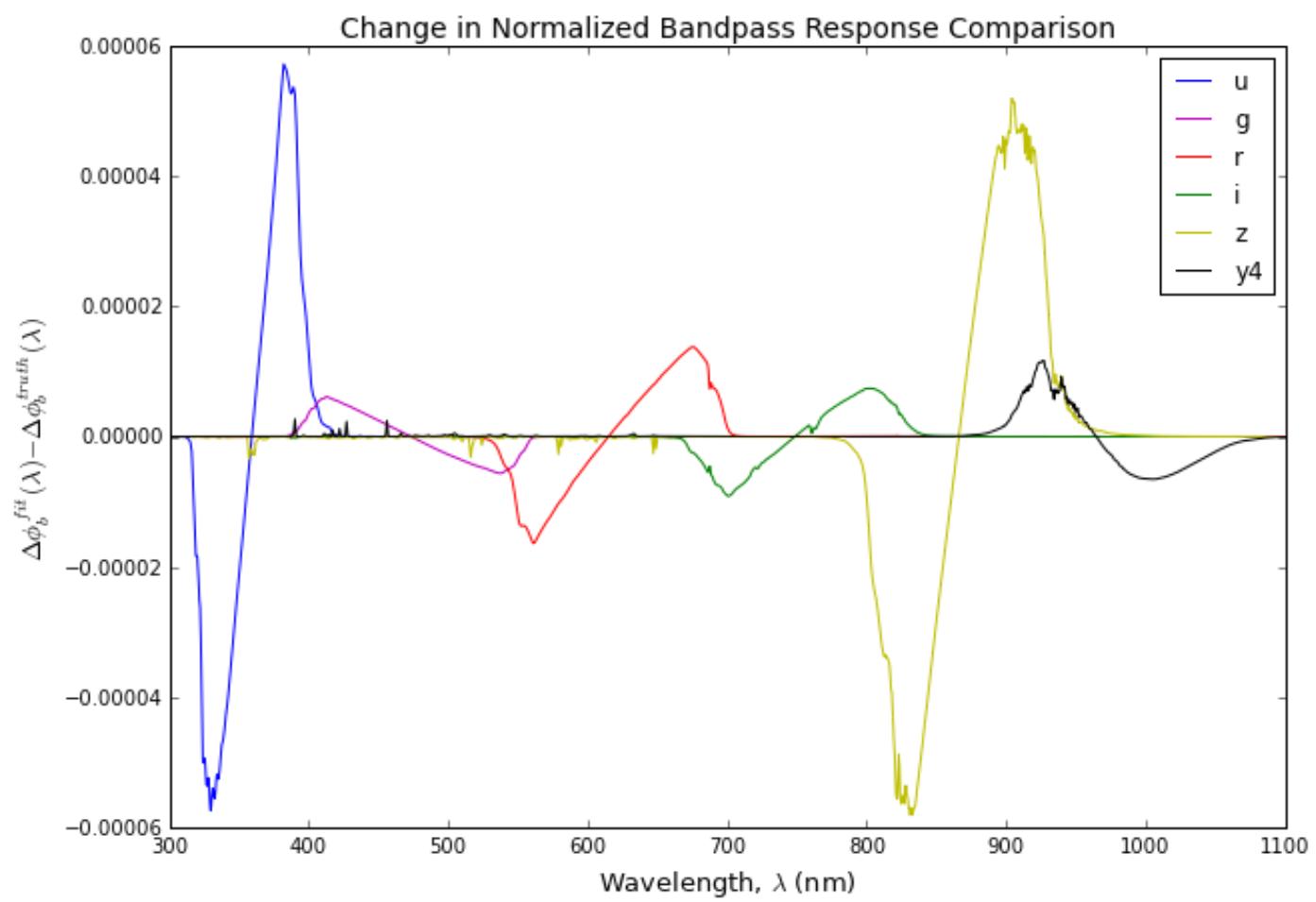
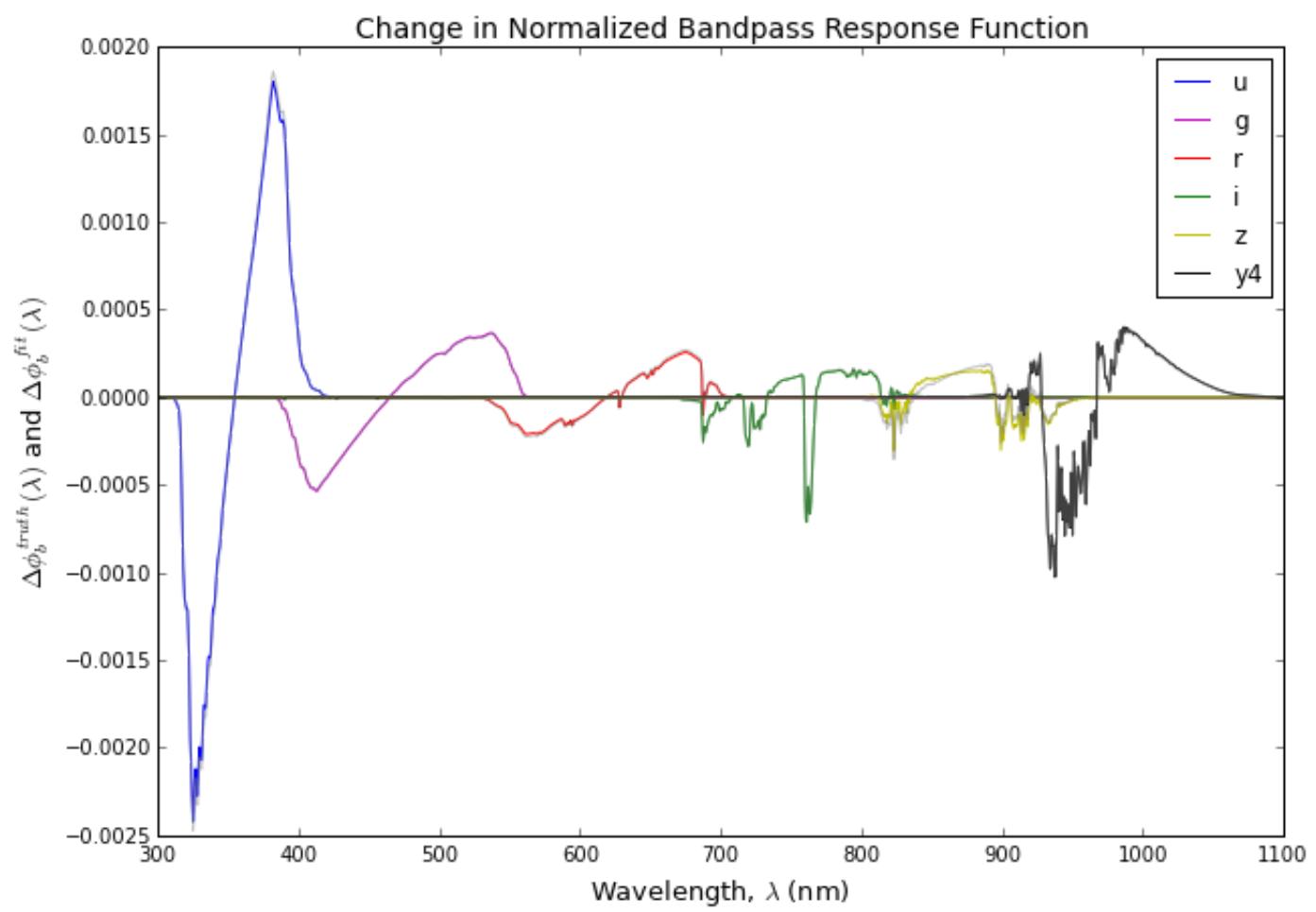
Best fit parameters (Filter, Aerosol, dG, logL, Chi-Squared):
u 1.08 11.02 1.28902421899 2.57804843797
g 0.98 11.84 1.28748141747 2.57496283494
r 1.08 11.84 0.358825519272 0.717651038545
i 1.08 11.84 0.509916372006 1.01983274401
z 1.96 11.84 0.403514010106 0.807028020212
y4 0.79 11.84 0.521622036472 1.04324407294

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

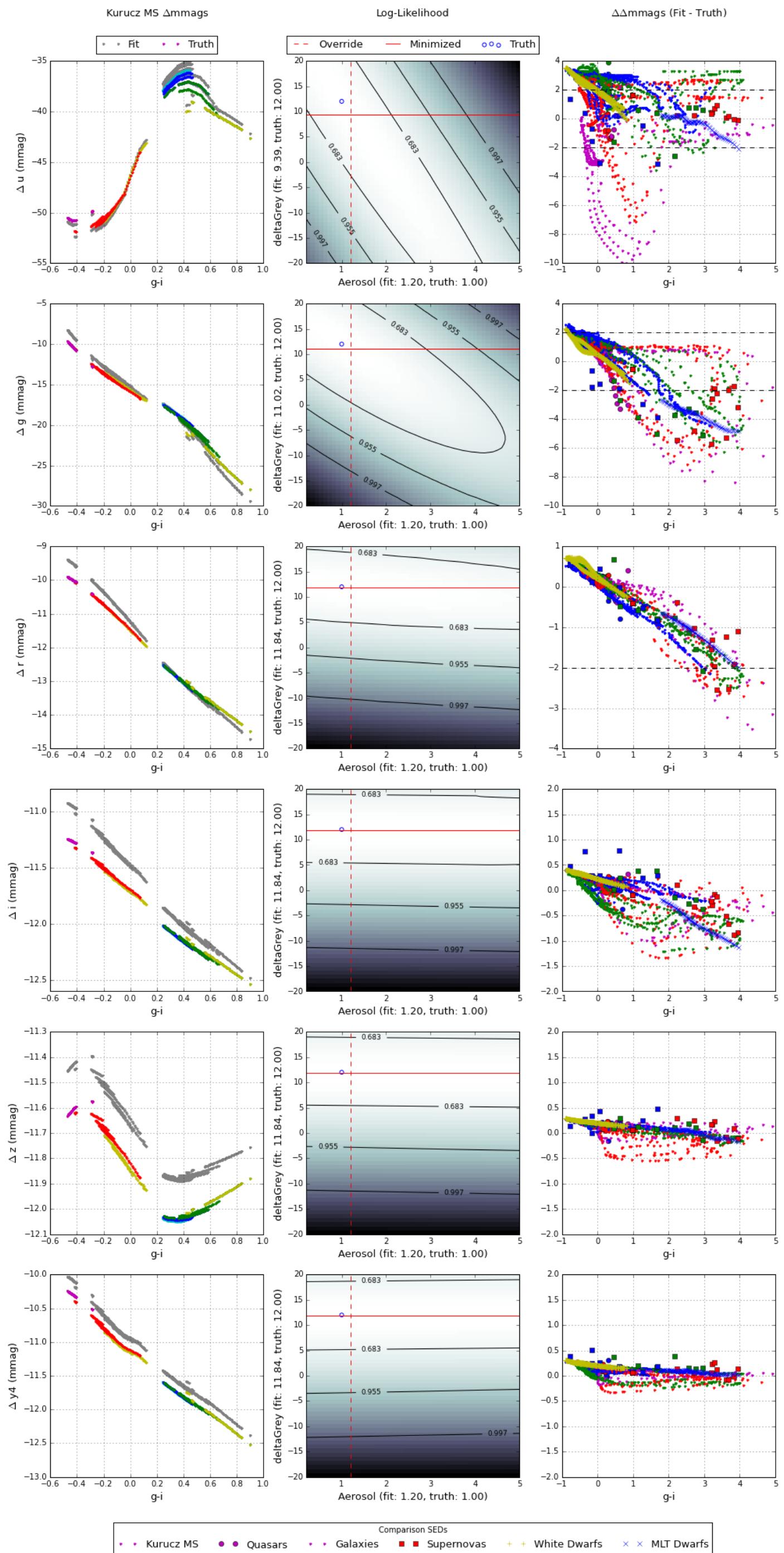
Computing nonlinear regression for Aerosol.
Observed atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]
Observed atmosphere airmass: 2.0
Standard atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]
Standard atmosphere airmass: 1.2
Observed atmosphere parameter for Aerosol: 1.0

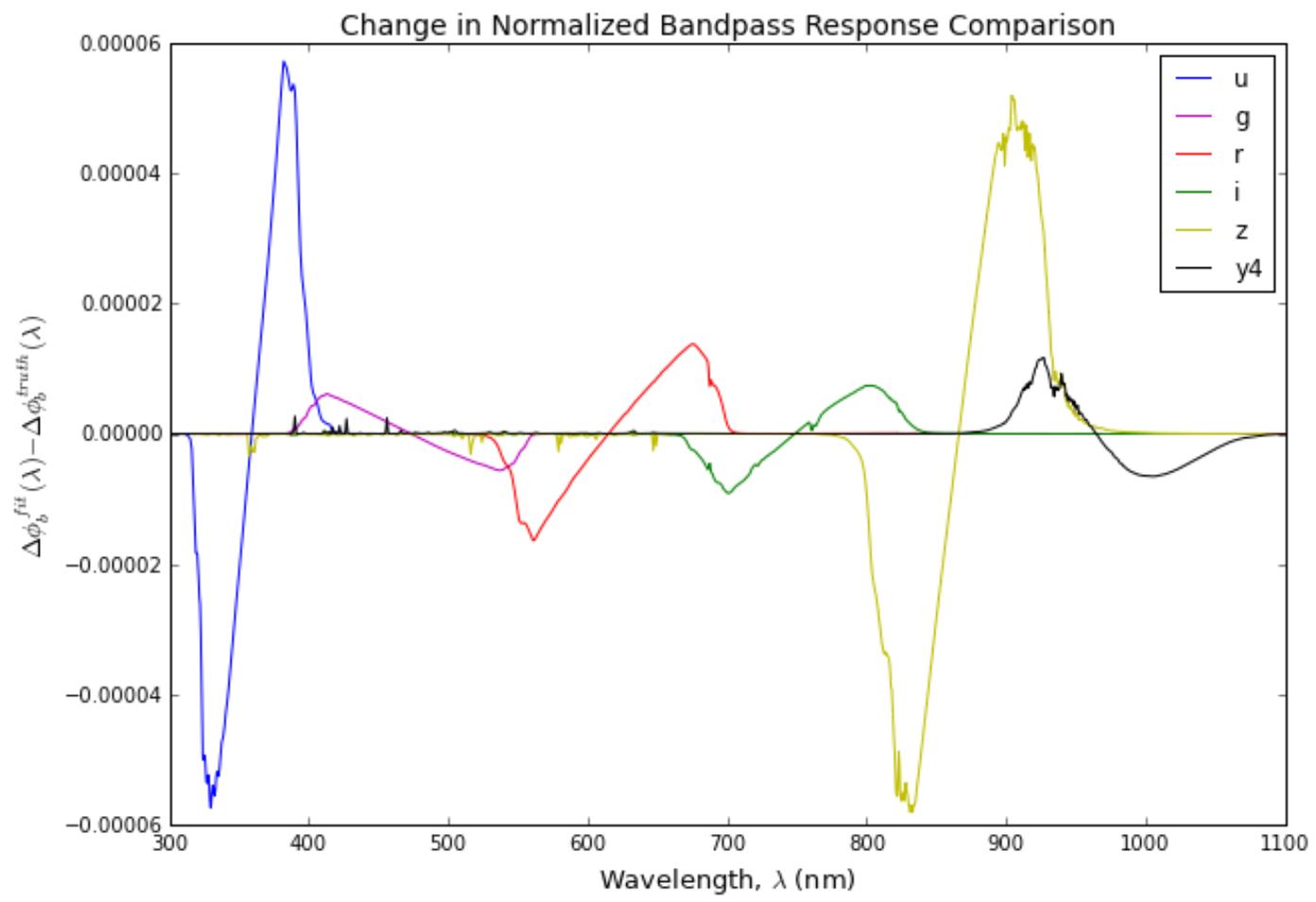
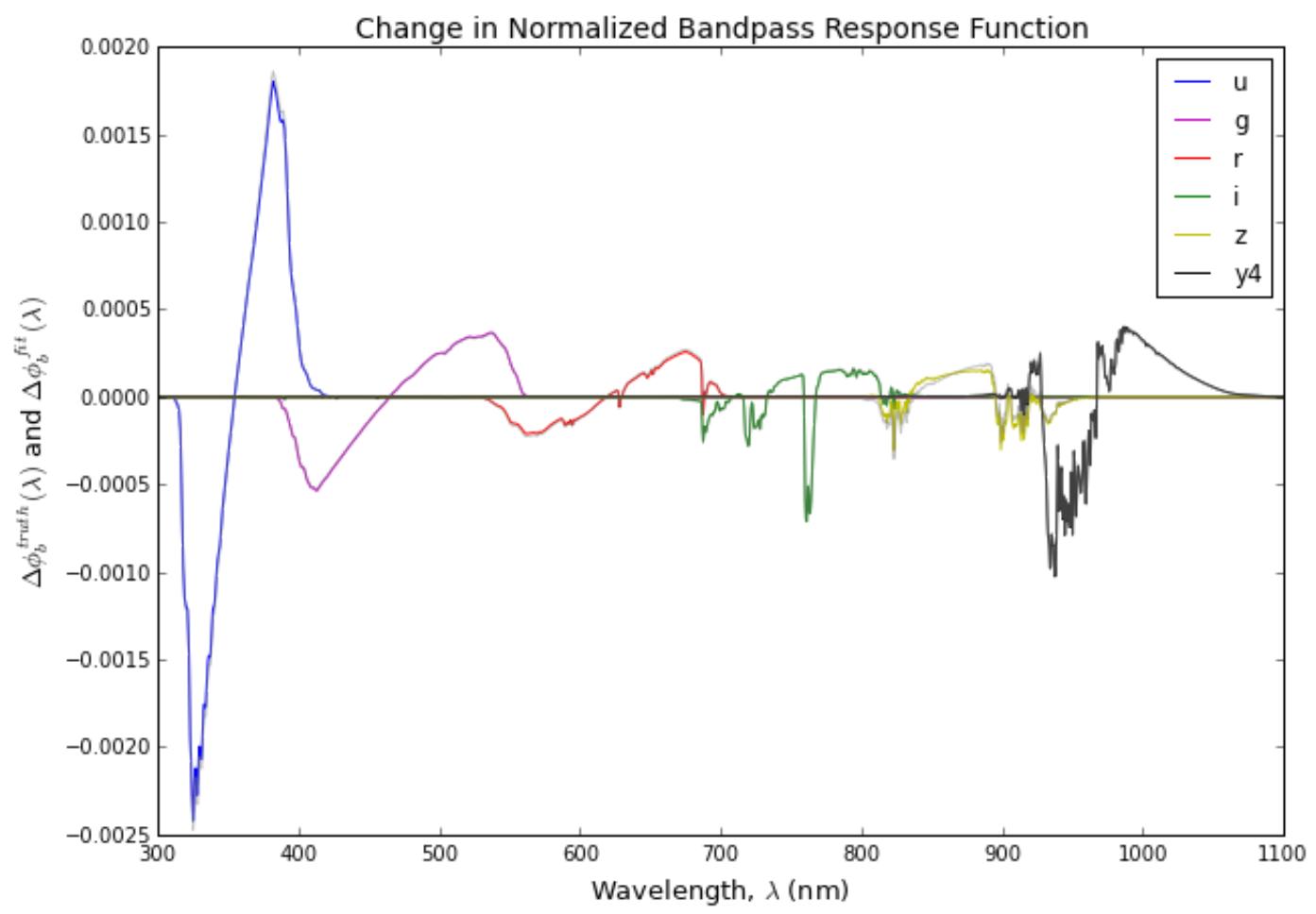
```

```
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: 988 Kurucz MS 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_DG120_DGR-2020_E5_mss_u_50dgb_50b_min_dGTest_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_DG120_DGR-2020_E5_mss_g_50dgb_50b_min_dGTest_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_DG120_DGR-2020_E5_mss_r_50dgb_50b_min_dGTest_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_DG120_DGR-2020_E5_mss_i_50dgb_50b_min_dGTest_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_DG120_DGR-2020_E5_mss_z_50dgb_50b_min_dGTest_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_DG120_DGR-2020_E5_mss_y4_50dgb_50b_min_dGTest_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 1.08 11.02 1.28902421899 2.57804843797  
g 0.98 11.84 1.28748141747 2.57496283494  
r 1.08 11.84 0.358825519272 0.717651038545  
i 1.08 11.84 0.509916372006 1.01983274401  
z 1.96 11.84 0.403514010106 0.807028020212  
y4 0.79 11.84 0.521622036472 1.04324407294  
  
Override best fit parameters (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
```

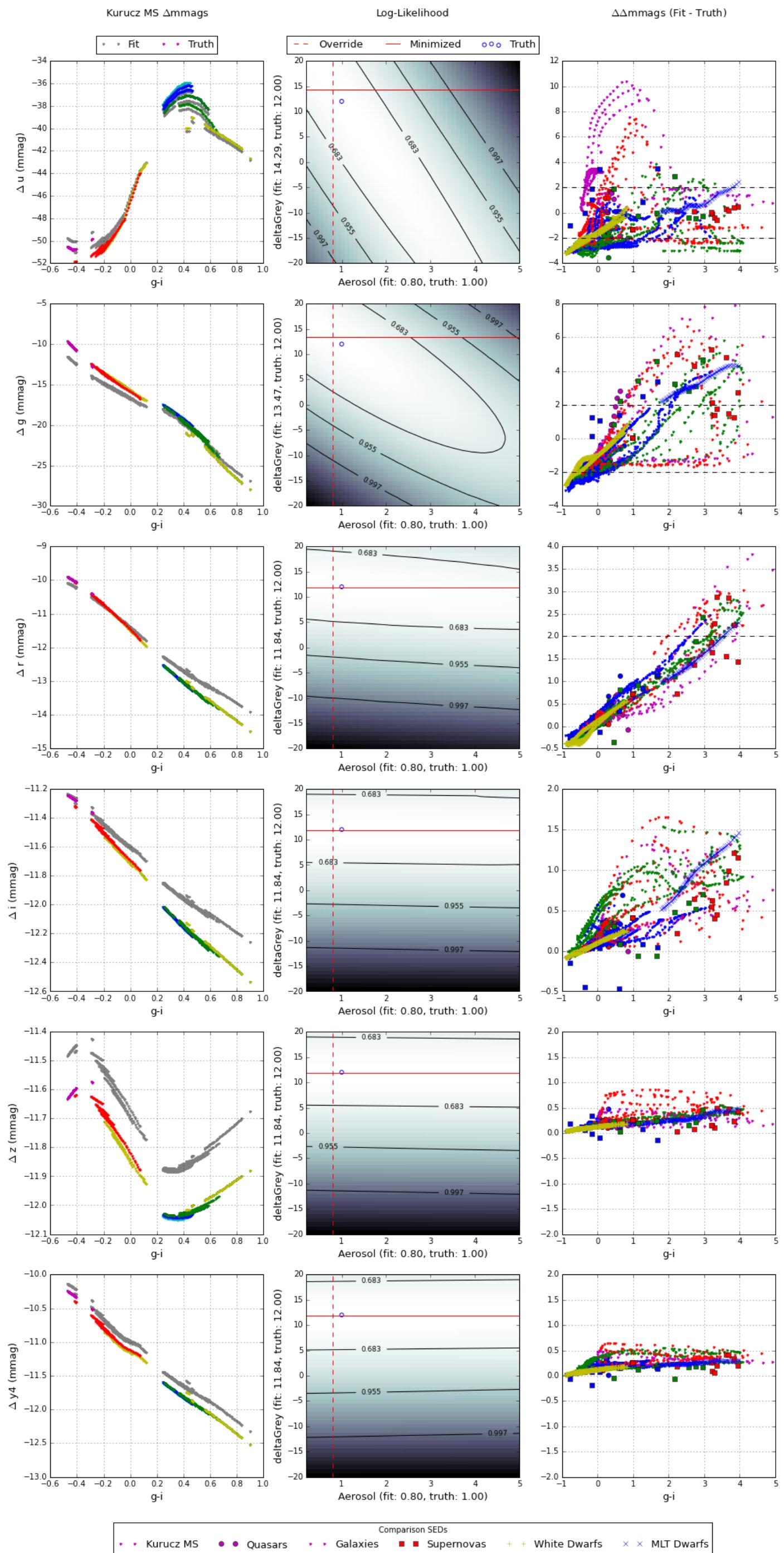


$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey}: 12.0$ )





$\Delta\text{mmags}$ , 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: 988 Kurucz MS 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_DGR-2020_E5_mss_u_51dgb_50b_max_dGTest_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_DGR-2020_E5_mss_g_51dgb_50b_max_dGTest_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_DGR-2020_E5_mss_r_51dgb_50b_max_dGTest_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_DGR-2020_E5_mss_i_51dgb_50b_max_dGTest_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_DGR-2020_E5_mss_z_51dgb_50b_max_dGTest_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_DGR-2020_E5_mss_y4_51dgb_50b_max_dGTest_OR120.pkl'
Saved LogL at best fit deltaGrey for y4 filter.
Saved Chi-Squared at best fit deltaGrey for y4 filter.
Completed y4 filter.

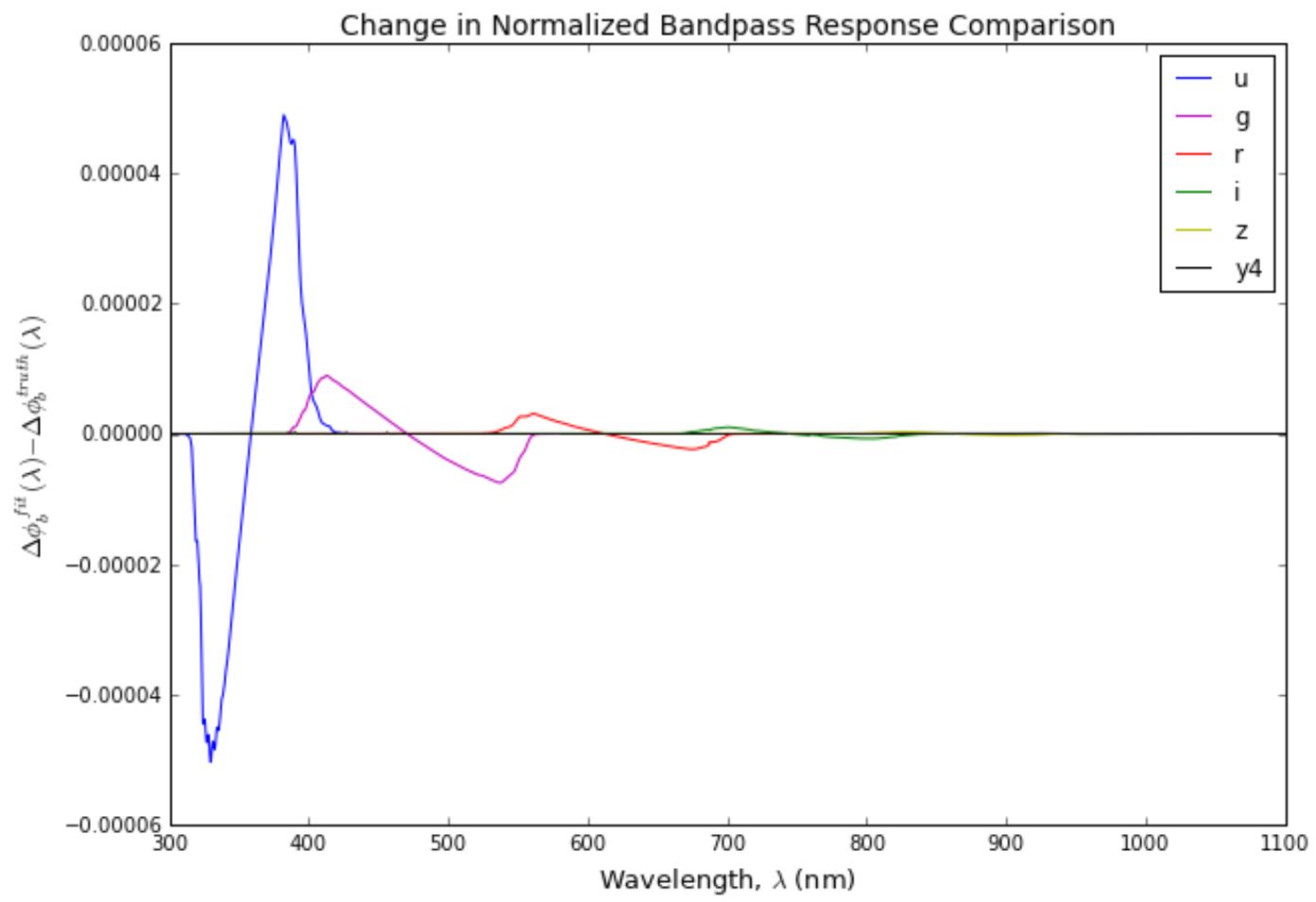
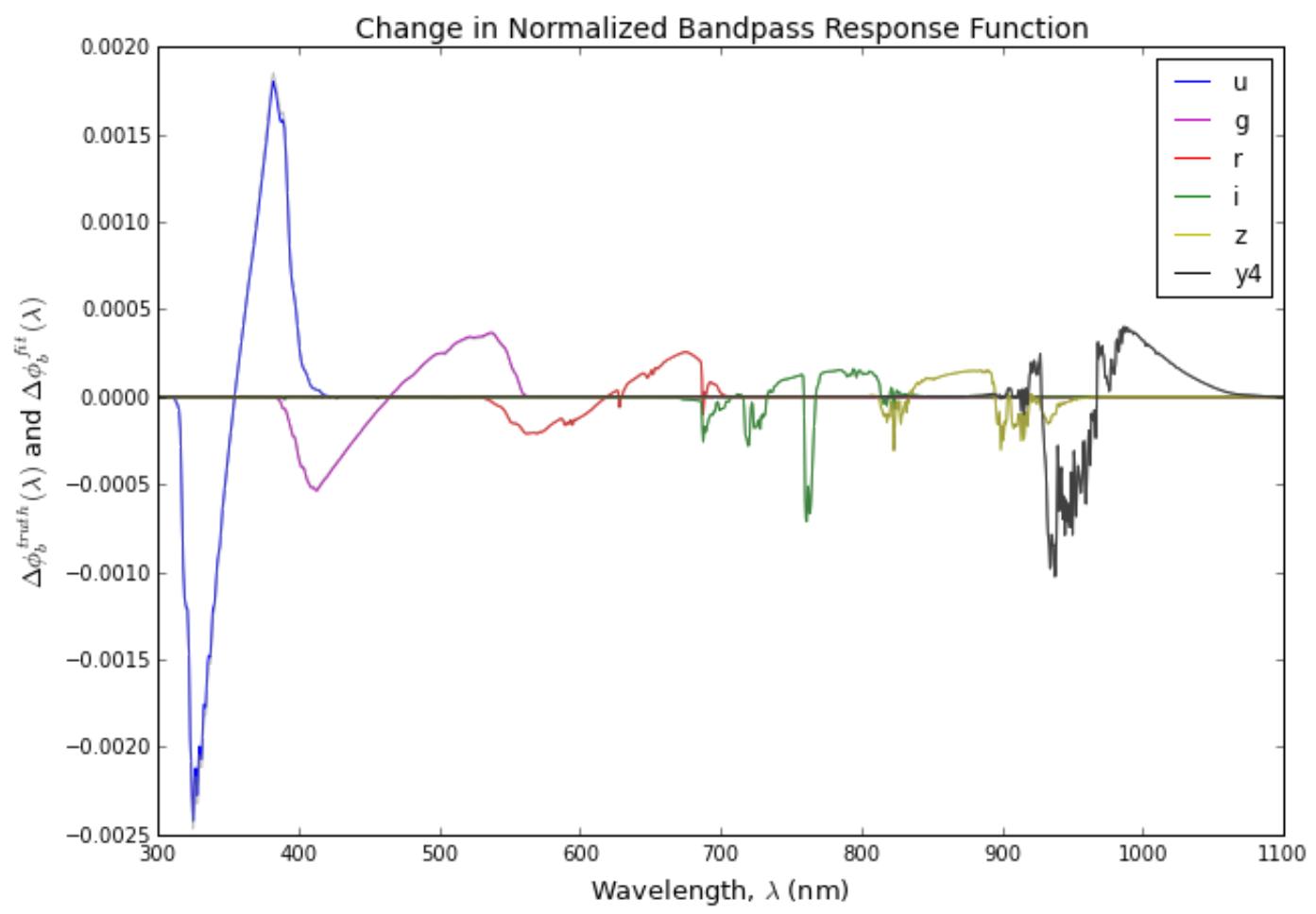
Best fit parameters (Filter, Alpha, dG, logL, Chi-Squared):
u 1.77 11.20 1.04693357413 2.09386714825
g 1.67 12.00 0.390214113798 0.780428227596
r 1.67 12.00 0.00526709594606 0.0105341918921
i 1.67 12.00 0.00016901414016 0.000338028280321
z 1.67 12.00 1.00337862345e-05 2.00675724691e-05
y4 1.67 12.00 1.02727735558e-05 2.05455471116e-05

Override best fit parameters (Filter, Alpha, dG):
u 1.20 17.60
g 1.20 13.60
r 1.20 12.00
i 1.20 12.00
z 1.20 12.00
y4 1.20 12.00

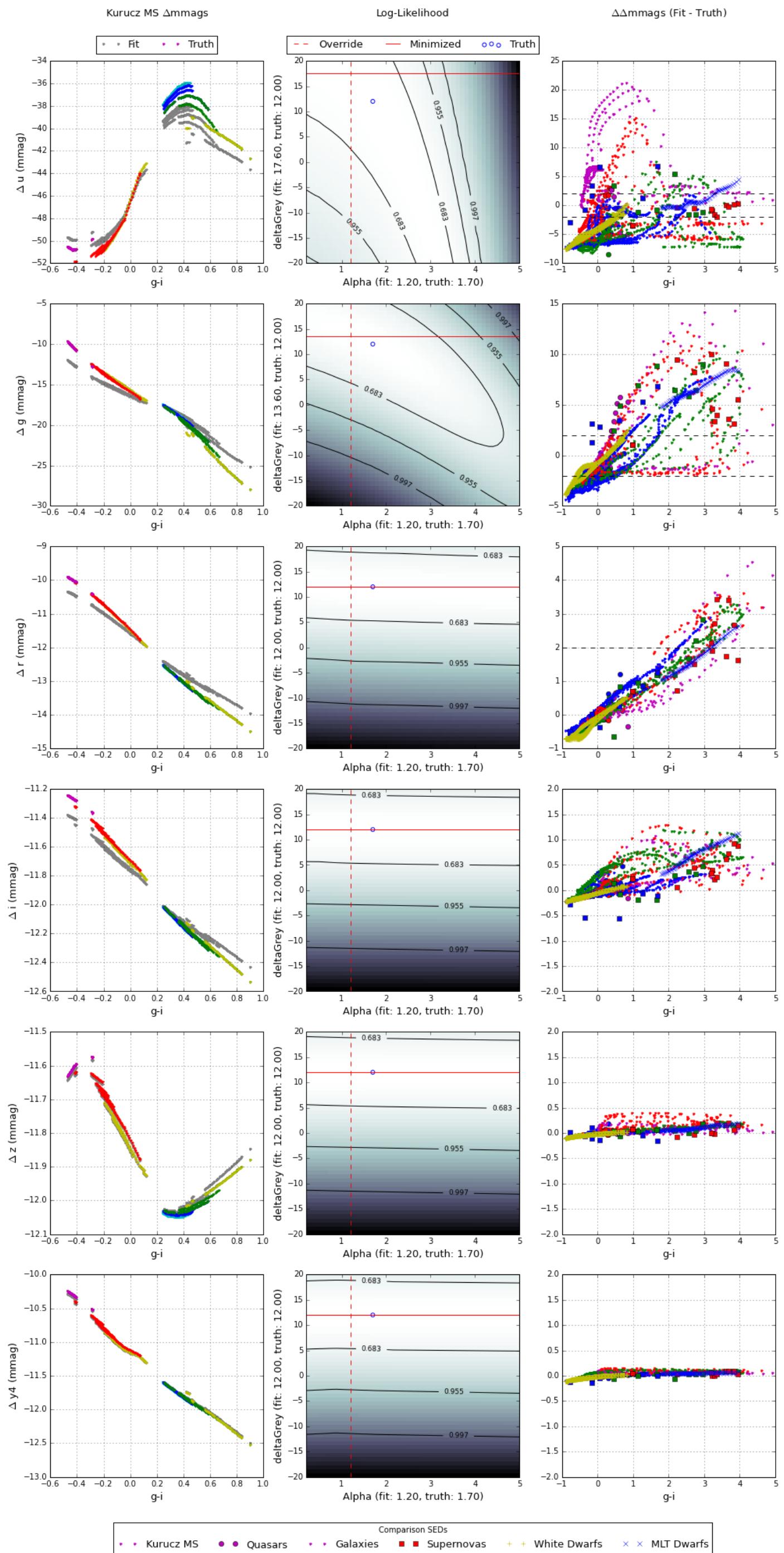
Computing nonlinear regression for Alpha.
Observed atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]
Observed atmosphere airmass: 2.0
Standard atmosphere parameters: [1.0, 1.0, 1.0, 1.0, 1.0, 1.7]
Standard atmosphere airmass: 1.2
Observed atmosphere parameter for Alpha: 1.7

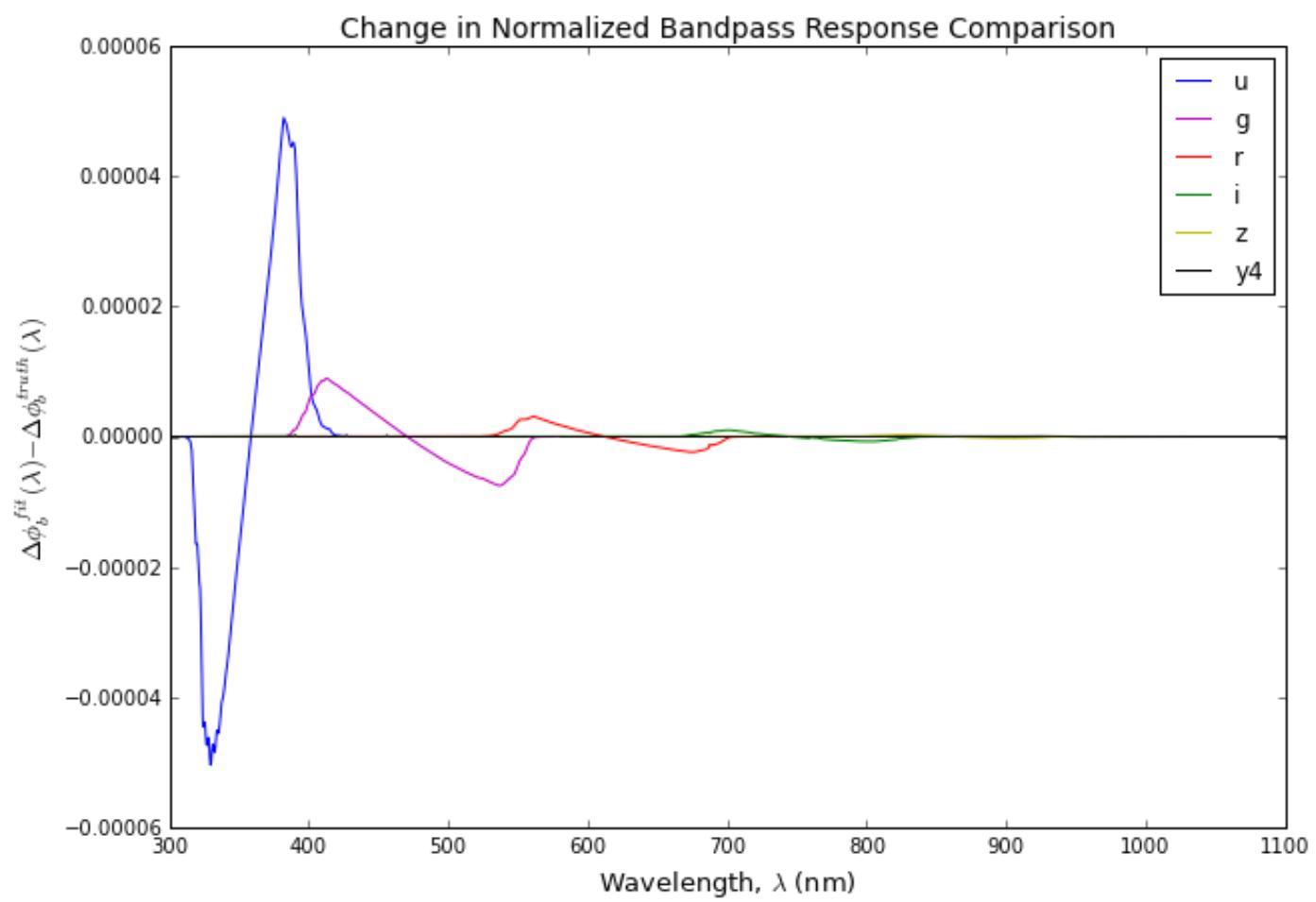
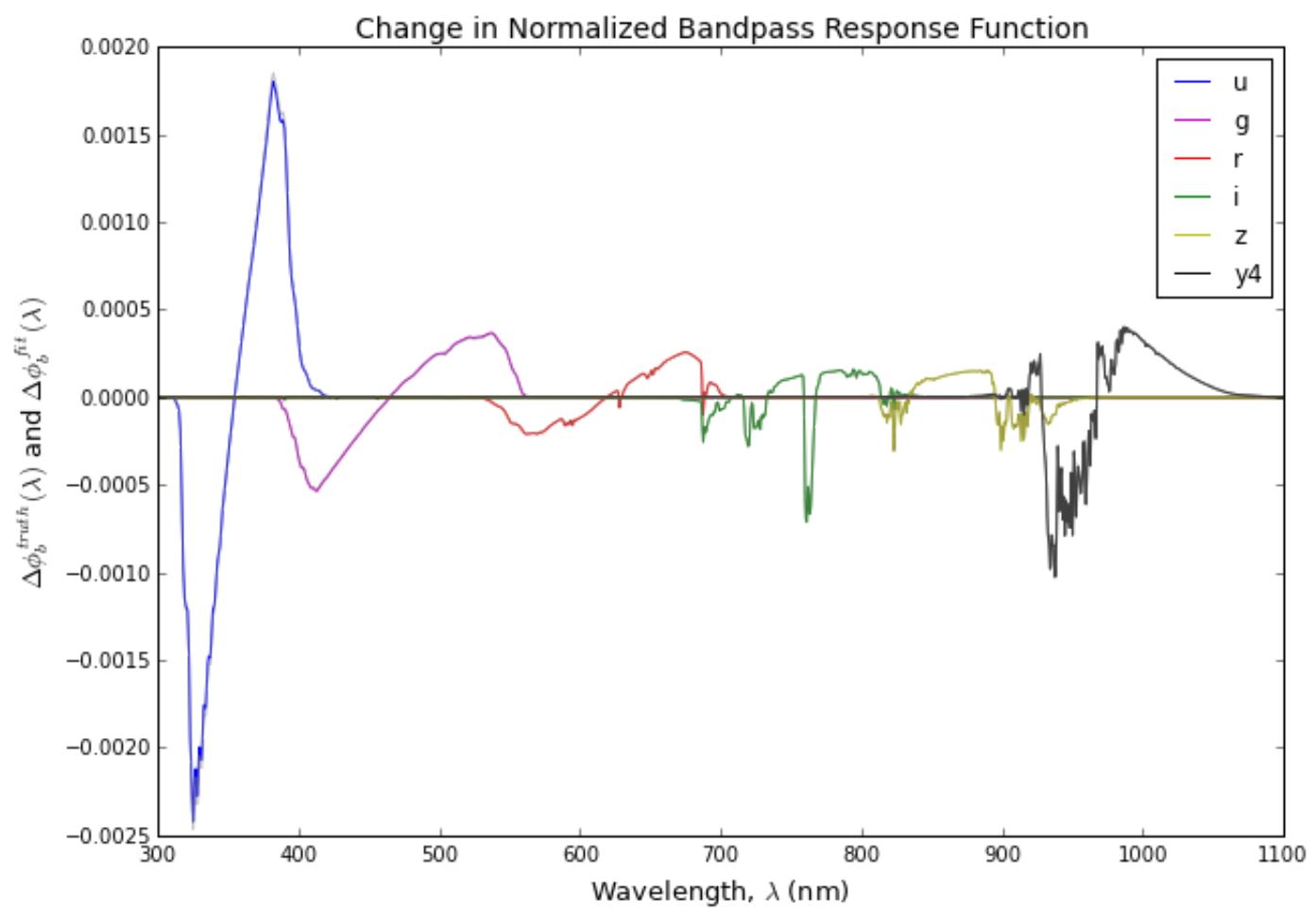
```

```
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: 988 Kurucz MS 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_DGR-2020_E5_mss_u_51dgb_50b_min_dGTest_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_DGR-2020_E5_mss_g_51dgb_50b_min_dGTest_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_DGR-2020_E5_mss_r_51dgb_50b_min_dGTest_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_DGR-2020_E5_mss_i_51dgb_50b_min_dGTest_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_DGR-2020_E5_mss_z_51dgb_50b_min_dGTest_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_DGR-2020_E5_mss_y4_51dgb_50b_min_dGTest_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 1.77 11.20 1.04693357413 2.09386714825  
g 1.67 12.00 0.390214113798 0.780428227596  
r 1.67 12.00 0.00526709594606 0.0105341918921  
i 1.67 12.00 0.00016901414016 0.000338028280321  
z 1.67 12.00 1.00337862345e-05 2.00675724691e-05  
y4 1.67 12.00 1.02727735558e-05 2.05455471116e-05  
  
Override best fit parameters (Filter, Alpha, 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
```

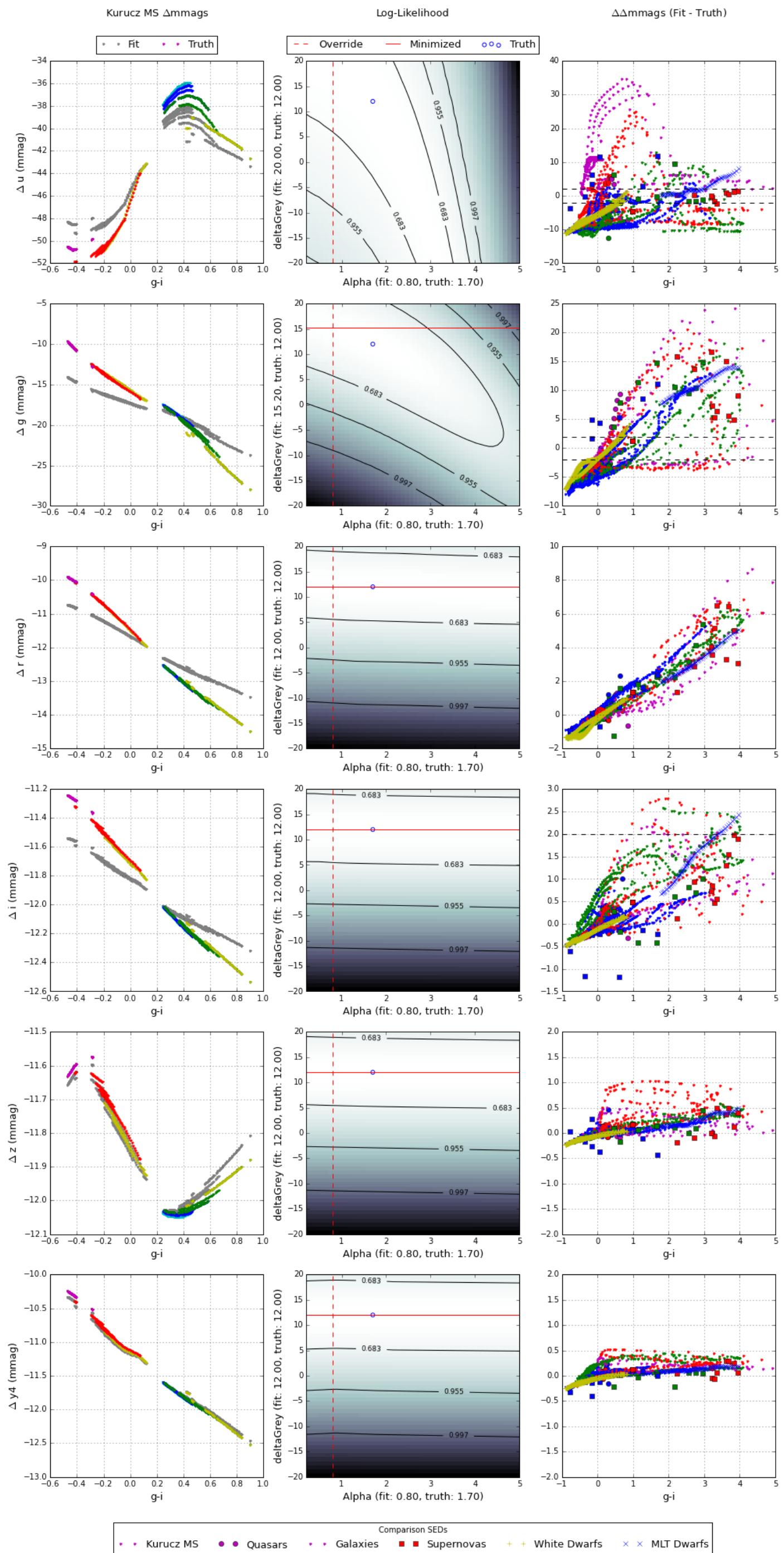


$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey}: 12.0$ )





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



```
In [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: 988 Kurucz MS 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_DGR-2020_E5_mss_u_50dgb_50b_max_dGTest_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_DGR-2020_E5_mss_g_50dgb_50b_max_dGTest_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_DGR-2020_E5_mss_r_50dgb_50b_max_dGTest_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_DGR-2020_E5_mss_i_50dgb_50b_max_dGTest_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_DGR-2020_E5_mss_z_50dgb_50b_max_dGTest_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_DGR-2020_E5_mss_y4_50dgb_50b_max_dGTest_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 1.77 11.02 0.978208201411 1.95641640282
g 1.77 11.84 0.694124807786 1.38824961557
r 1.87 11.84 0.356098129248 0.712196258496
i 5.00 11.84 0.34550686895 0.691013737901
z 5.00 11.84 0.274004731836 0.548009463673
y4 5.00 11.84 0.21259499907 0.425189998139

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: 988 Kurucz MS 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_DGR-2020_E5_mss_u_50dgb_50b_min_dGTest_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_DGR-2020_E5_mss_g_50dgb_50b_min_dGTest_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_DGR-2020_E5_mss_r_50dgb_50b_min_dGTest_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_DGR-2020_E5_mss_i_50dgb_50b_min_dGTest_OR80.pkl'
Saved LogL at best fit deltaGrey for i filter.
Saved Chi-Squared at best fit deltaGrey for i filter.
Completed i filter.

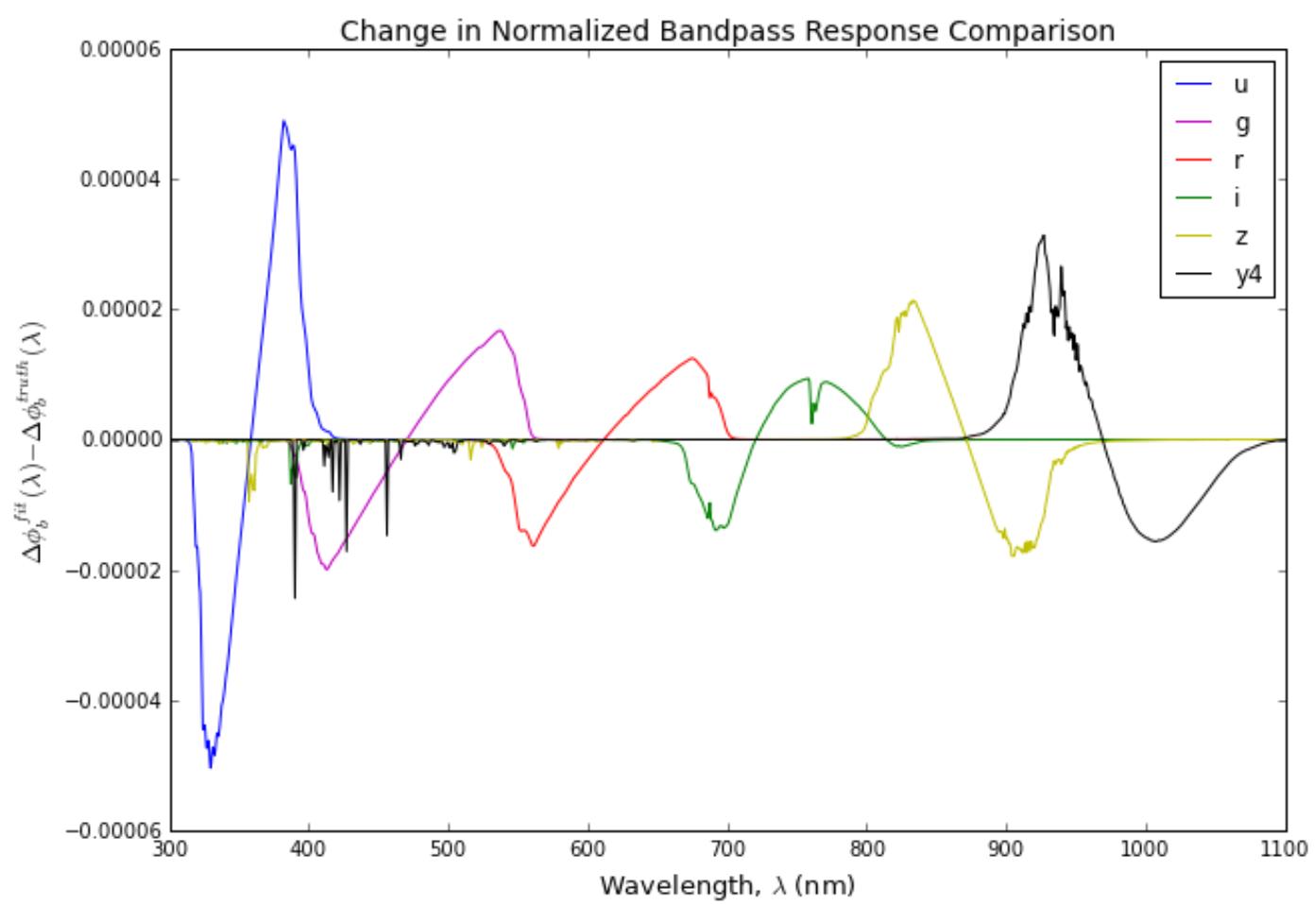
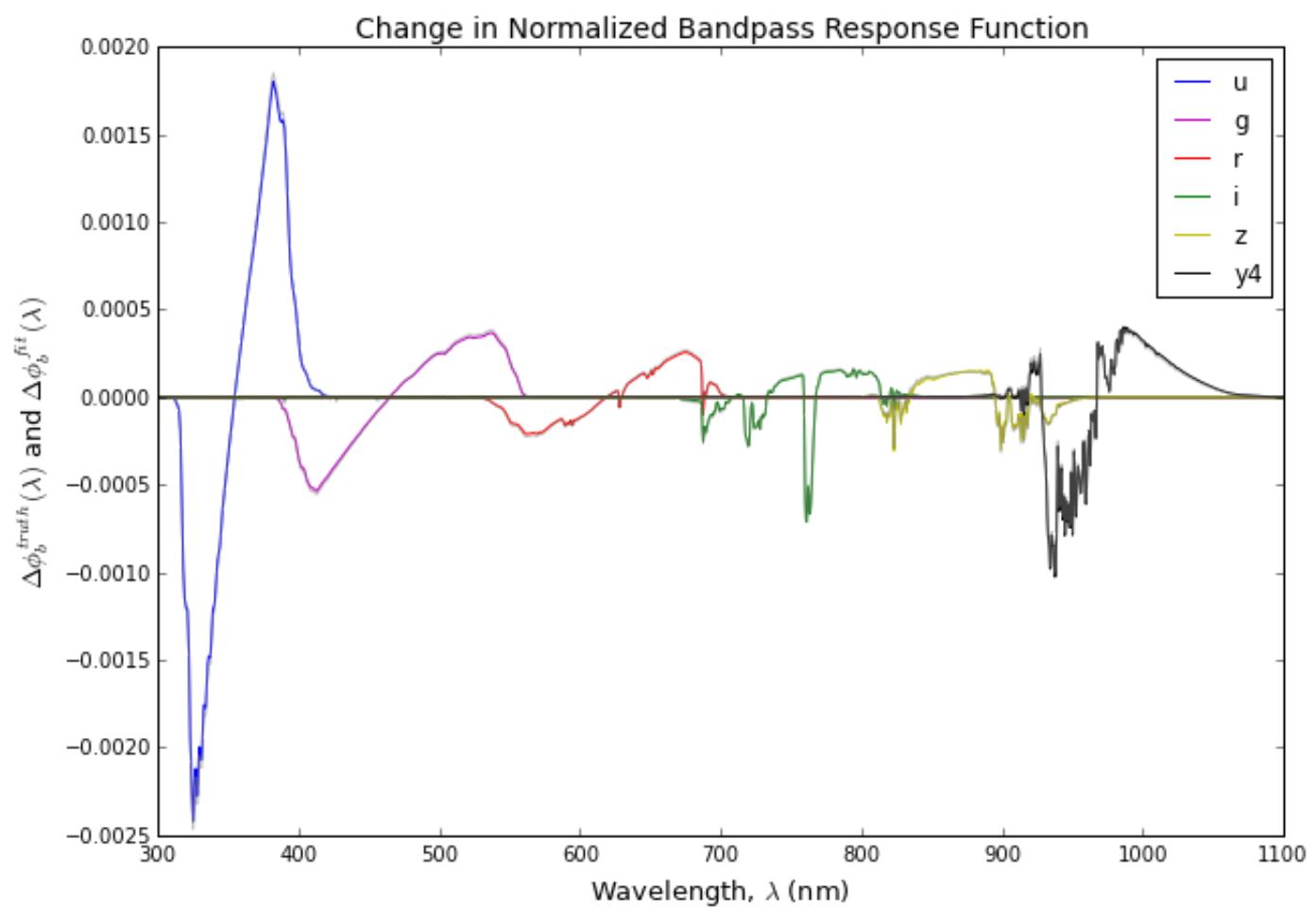
Calculating best fit parameters for z filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Alpha_dG_XSTD12_DG120_DGR-2020_E5_mss_z_50dgb_50b_min_dGTest_OR80.pkl'
Saved LogL at best fit deltaGrey for z filter.
Saved Chi-Squared at best fit deltaGrey for z filter.
Completed z filter.

Calculating best fit parameters for y4 filter...
@pickle_results: computing results and saving to 'pickles/X20_P101010101017_Alpha_dG_XSTD12_DG120_DGR-2020_E5_mss_y4_50dgb_50b_min_dGTest_OR80.pkl'
Saved LogL at best fit deltaGrey for y4 filter.
Saved Chi-Squared at best fit deltaGrey for y4 filter.
Completed y4 filter.

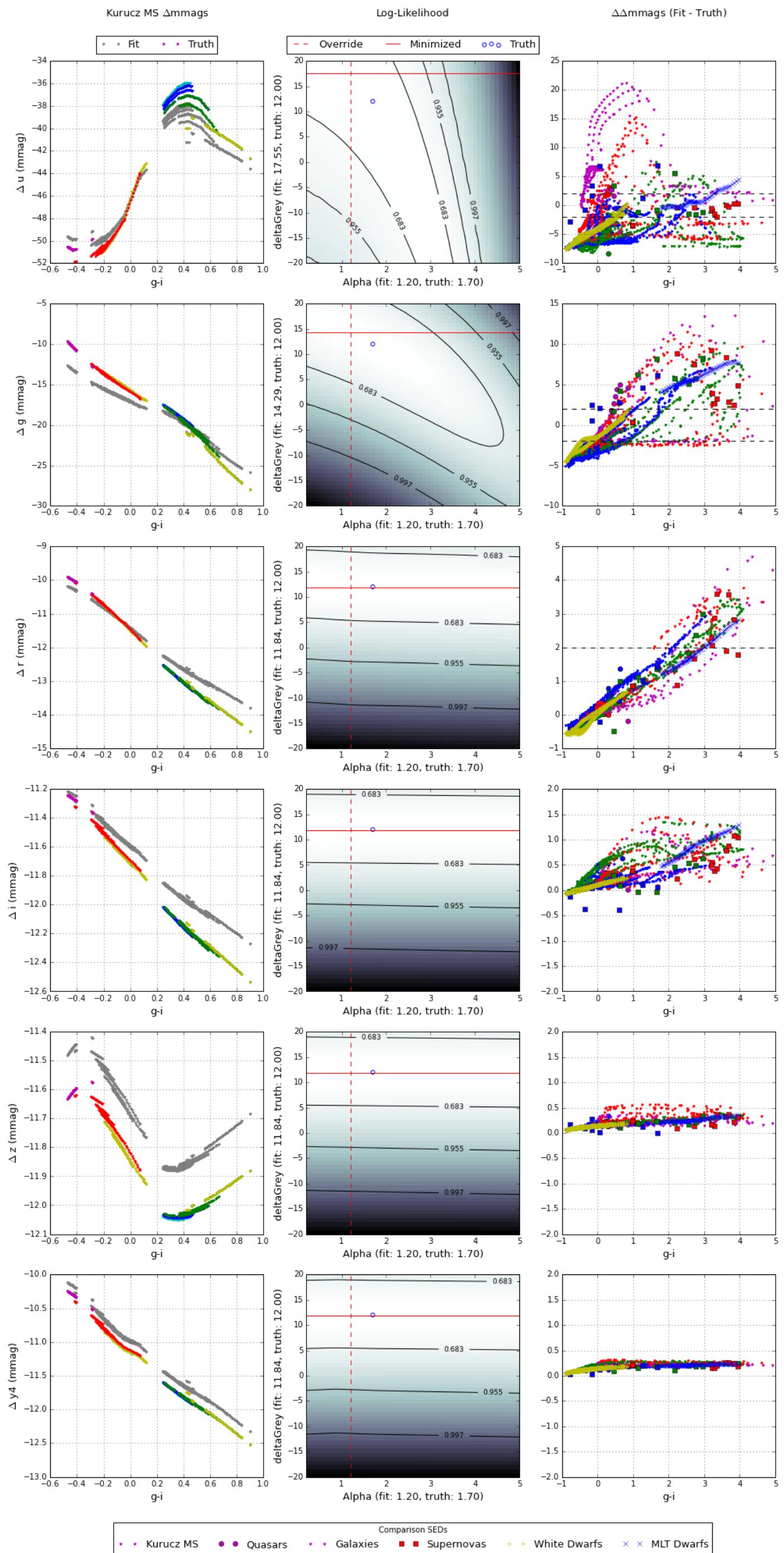
Best fit parameters (Filter, Alpha, dG, logL, Chi-Squared):
u 1.77 11.02 0.978208201411 1.95641640282
g 1.77 11.84 0.694124807786 1.38824961557
r 1.87 11.84 0.356098129248 0.712196258496
i 5.00 11.84 0.34550686895 0.691013737901
z 5.00 11.84 0.274004731836 0.548009463673
y4 5.00 11.84 0.21259499907 0.425189998139

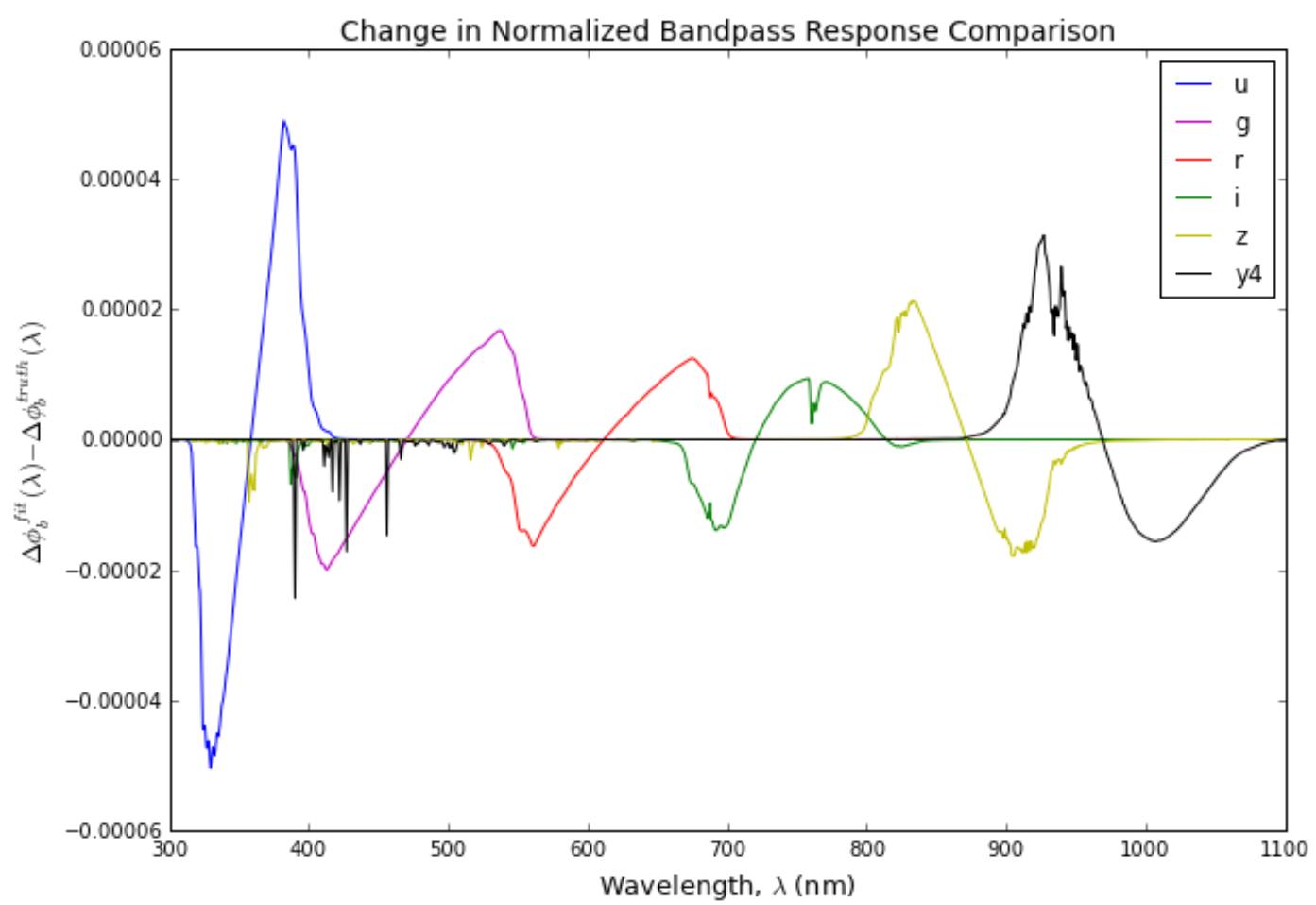
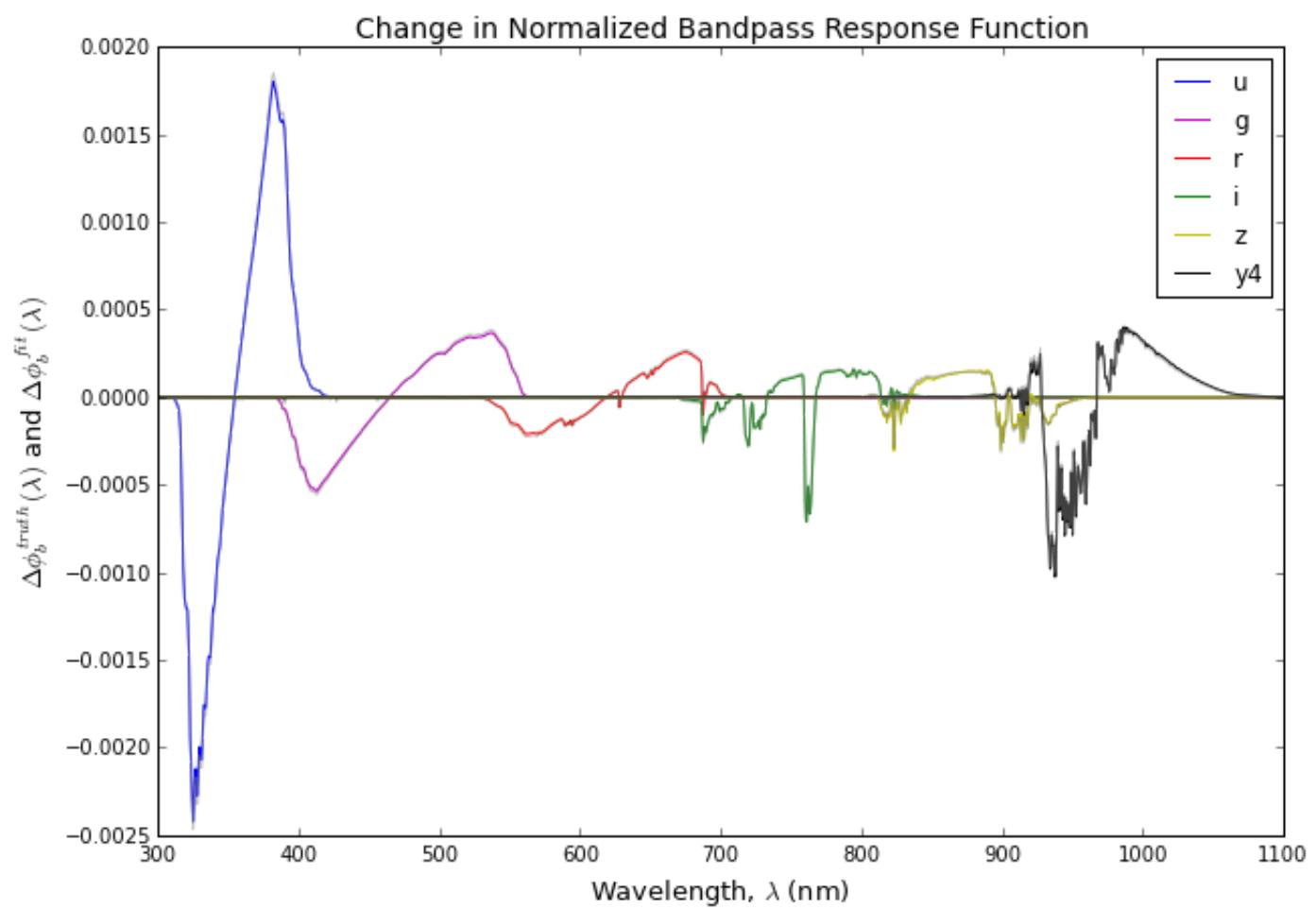
Override best fit parameters (Filter, Alpha, dG):
u 0.80 20.00
g 0.80 15.10
r 0.80 12.65
i 0.80 11.84
z 0.80 11.84
y4 0.80 11.84

```

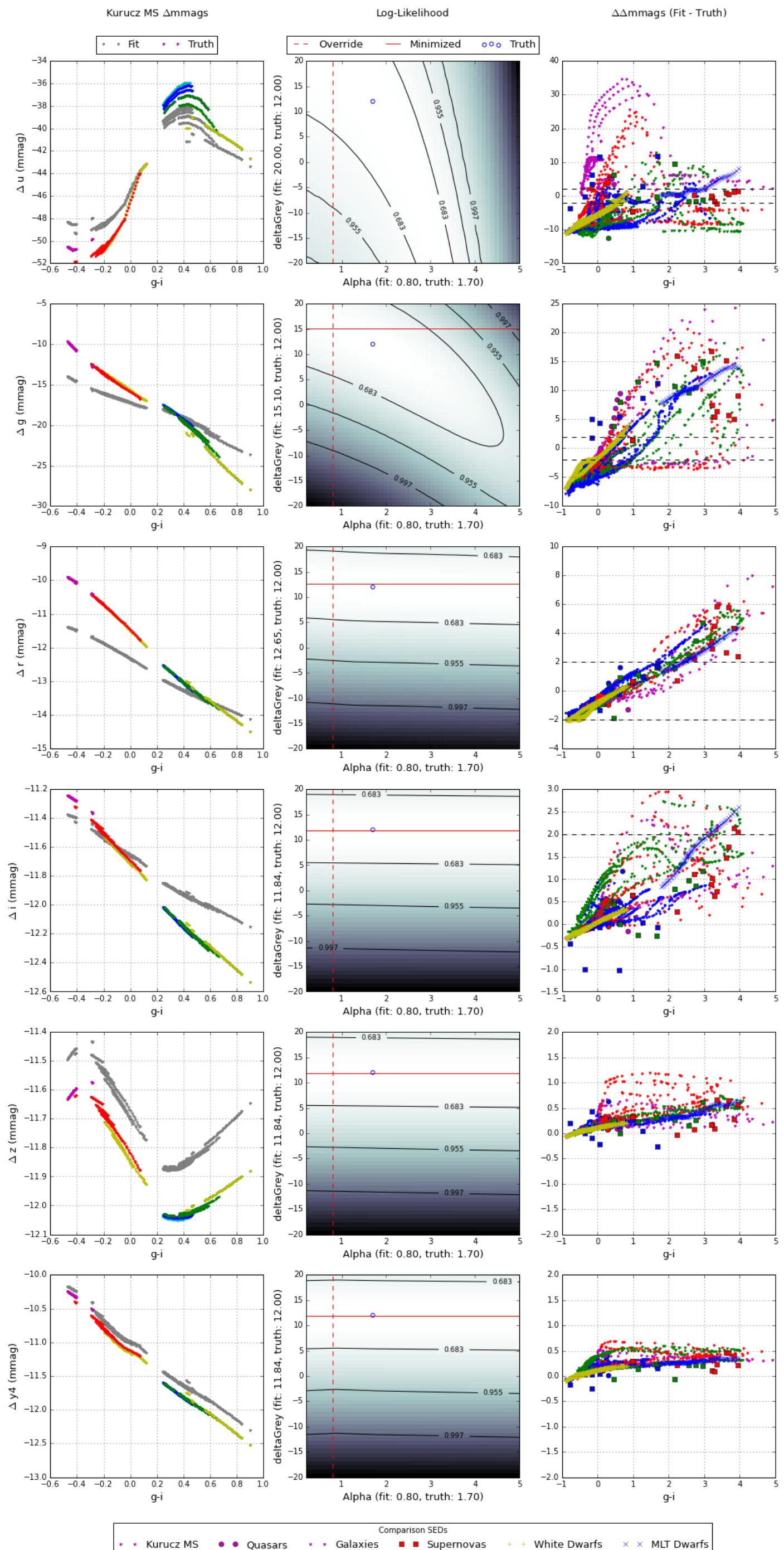


$\Delta\text{mmags}$ , Regression Contours,  $\Delta\Delta\text{mmags}$  for each LSST filter ( $\delta\text{Grey}: 12.0$ )





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



In [ ]: