Galaxy-galaxy lensing tests for KiDS-1000 vs. BOSS/2dFLenS

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Goals

Investigate implementation of galaxy-galaxy lensing component of KiDS-1000 Phase 1

- Can galaxy-galaxy lensing around BOSS and 2dFLenS be consistently combined?

- What are the key systematics to address?

- Should any weights be applied to reduce systematic bias, or optimize statistical error?

Default galaxy-galaxy lensing analysis

- Use KiDS-1000 source catalogues downloaded 29/10/18 (K1000_N/S_9band_mask_BLINDED.cat)

- Measure galaxy-galaxy lensing $\Delta\Sigma(R)$ around BOSS/2dFLenS LRGs in redshift ranges 0.15 < z < 0.43 and 0.43 < z < 0.7. Note: I call these LOWZ/CMASS and 2dFLoZ/2dFHiZ

- Cut sources to $0.1 < z_B < 1.2$ and source/lens samples to KiDS tiles which contain lenses

- Default analysis: subtract $\Delta\Sigma_{rand}(R)$ using random lenses, include boost correction, no multiplicative bias correction, use jack-knife errors with KiDS tiles as JK regions

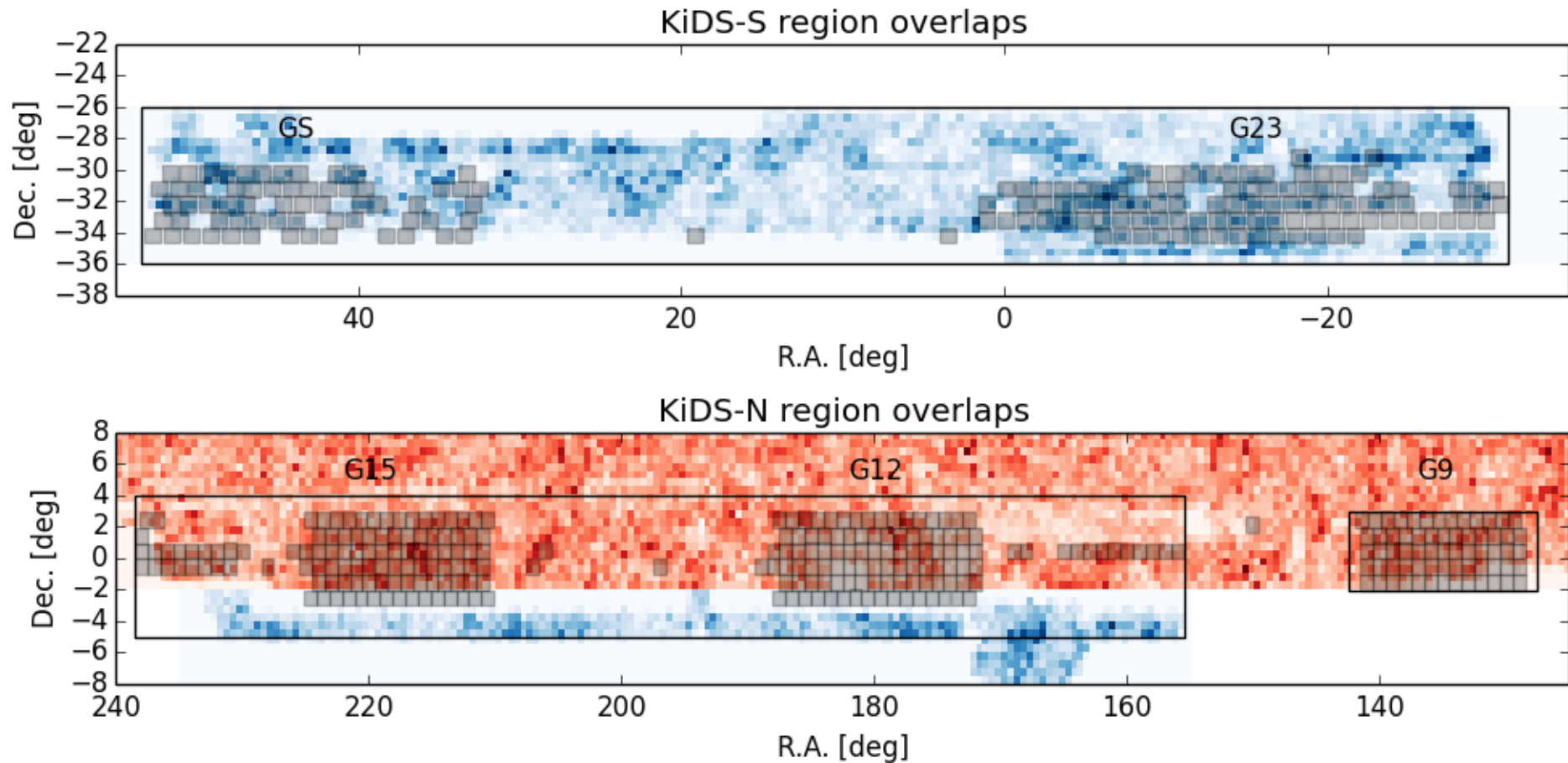- Default linear bias fits: use KV-450 source N(z), Planck-like fiducial cosmology, fit to scales $R > 3\ h^{-1}$ Mpc

Overlap (KiDS-1000)

Blue=2dFLenS   Red=BOSS   Grey=KiDS tiles

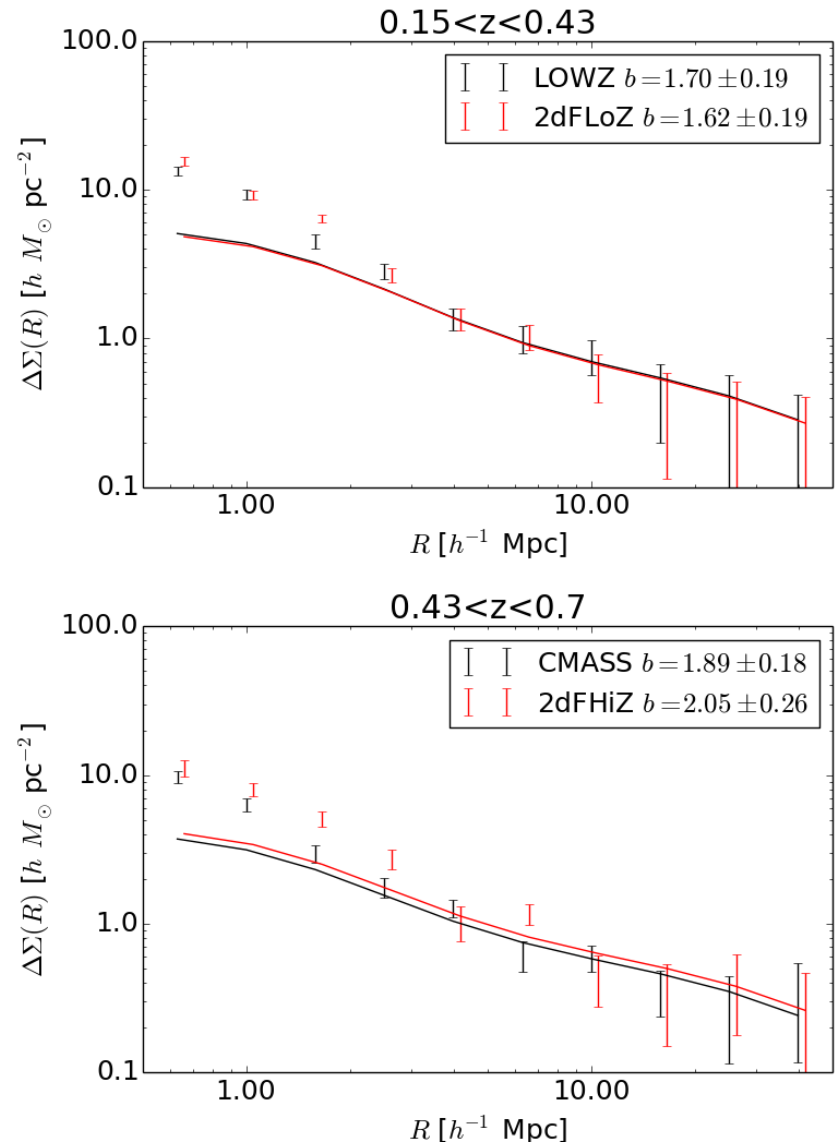KiDS-S region overlaps

KiDS-N region overlaps
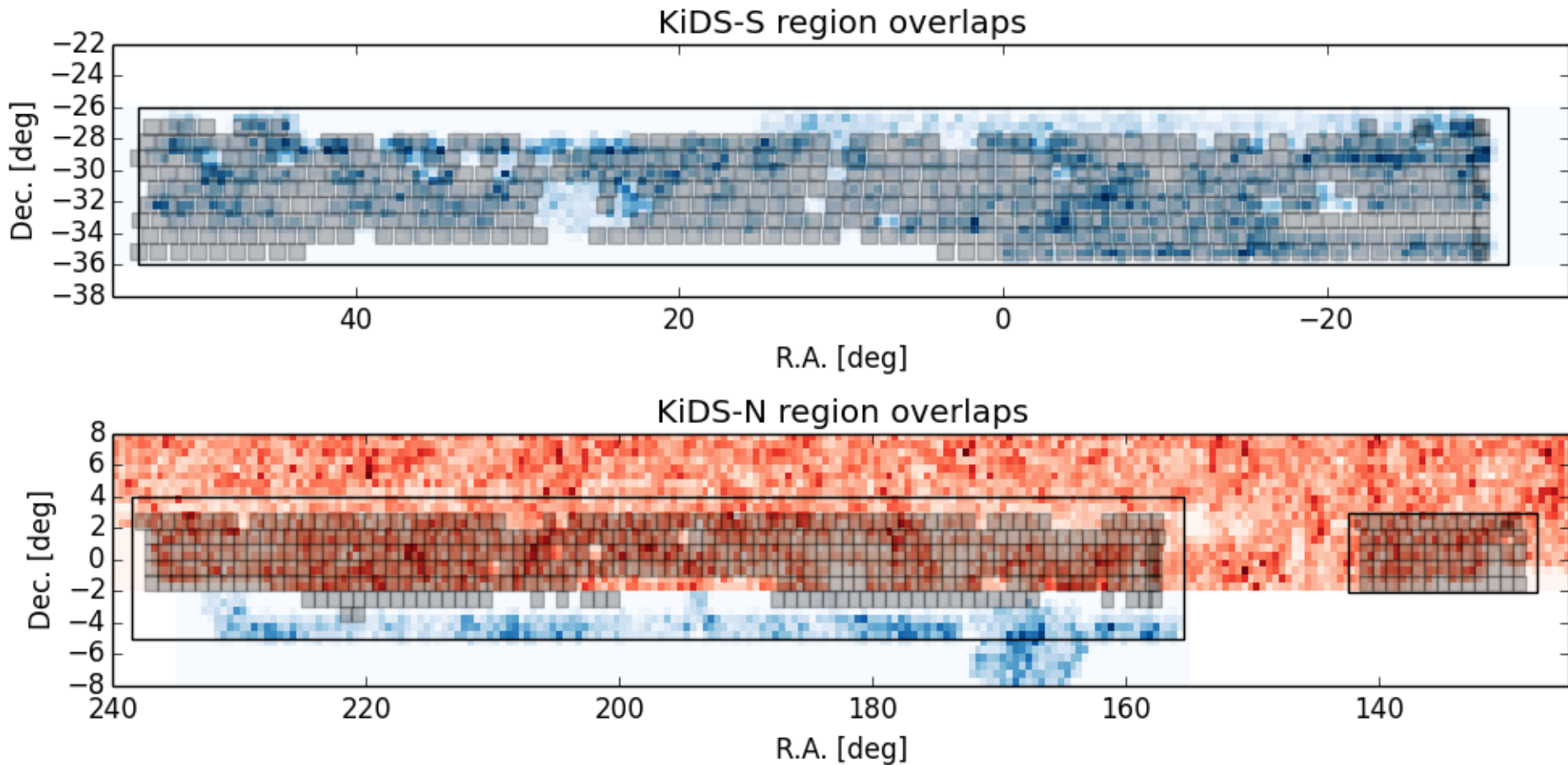
Overlap (KiDS-450)

*Blue=2dFLenS*   *Red=BOSS*   *Grey=KiDS tiles*

Are BOSS and 2dFLenS consistent?

- These are measurements of $\Delta\Sigma(R)$ for BOSS/2dFLenS LRGs, in redshift ranges 0.15-0.43 and 0.43-0.7

- There is evidence for some differences on 1-halo scales ($R < 3\ h^{-1}$ Mpc), particularly for 0.43-0.7, but on larger scales the amplitudes are consistent

- *Note: not much GGL signal on scales $R > 10\ h^{-1}\ Mpc$*

0.15<z<0.43

| | | LOWZ $b = 1.70 \pm 0.19$ |
| | | 2dFLoZ $b = 1.62 \pm 0.19$ |

$\Delta\Sigma(R)\ [h\ M_\odot\ pc^{-2}]$

$R\ [h^{-1}\ Mpc]$

0.43<z<0.7

| | | CMASS $b = 1.89 \pm 0.18$ |
| | | 2dFHiZ $b = 2.05 \pm 0.26$ |

$\Delta\Sigma(R)\ [h\ M_\odot\ pc^{-2}]$

$R\ [h^{-1}\ Mpc]$

Are BOSS and 2dFLenS consistent?

- Here are the posterior probability distributions of the linear bias fits to $\Delta\Sigma(R)$ (the fits are to scales $R > 3 \ h^{-1}$ Mpc)
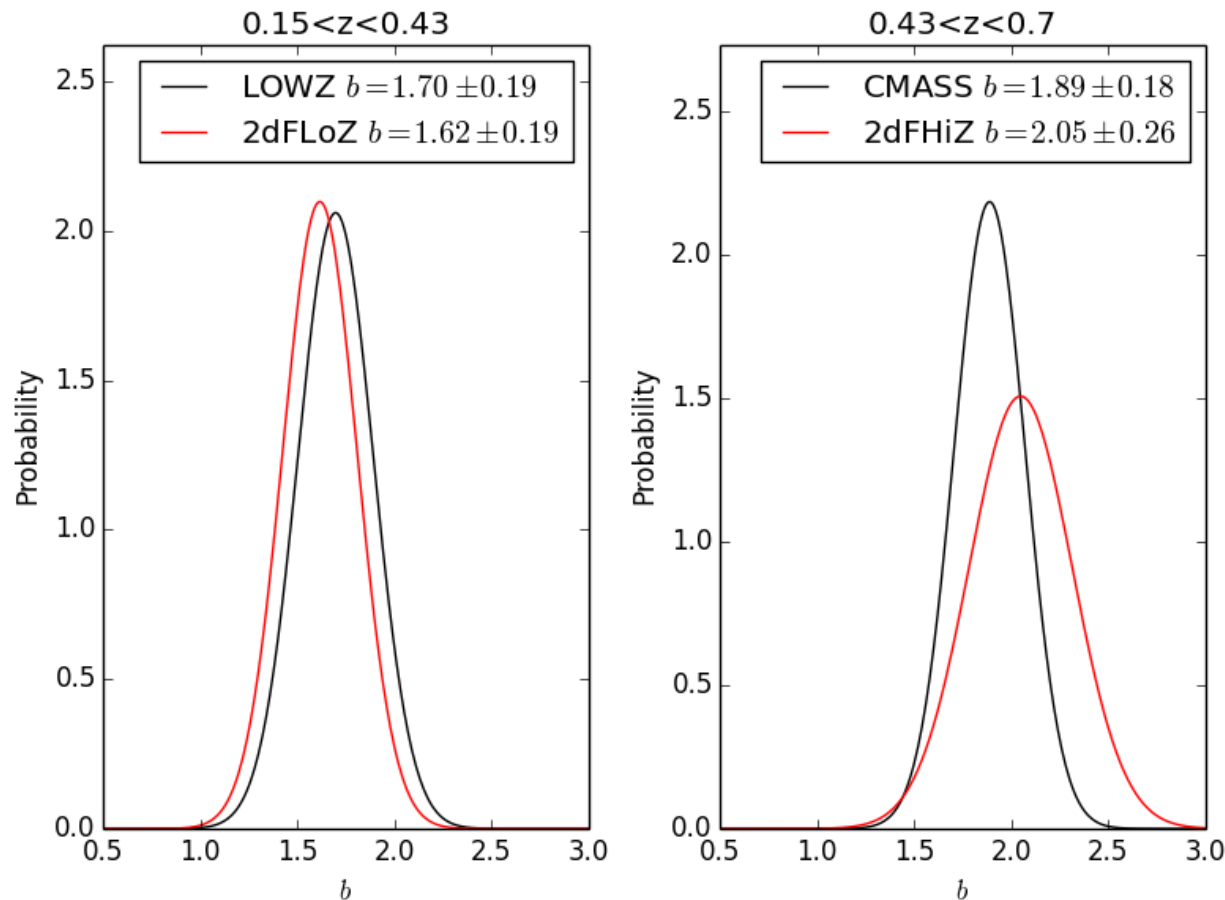
Are BOSS and 2dFLenS consistent?

- I have matched BOSS and 2dFLenS galaxies to the KiDS-1000 source catalogue *(use "MAG_GAAP" values?)*

- Key colours/magnitudes for LRG selection are: $g - r$, $r - i$, i. This plot compares their distributions for CMASS/2dFHiZ. *(Could weight sources to match these distributions).*

- *Note: there are almost no matches for LOWZ selection*
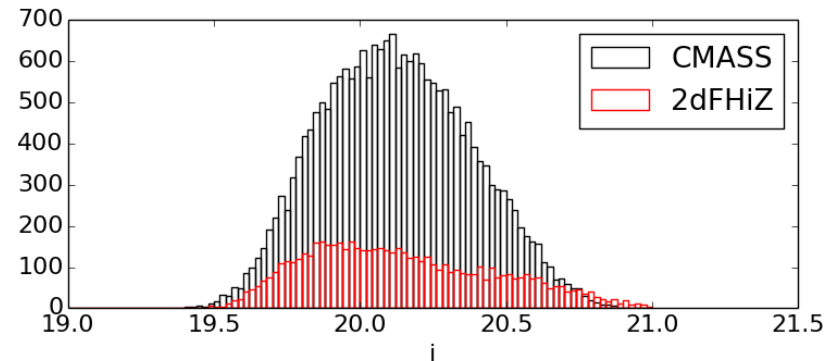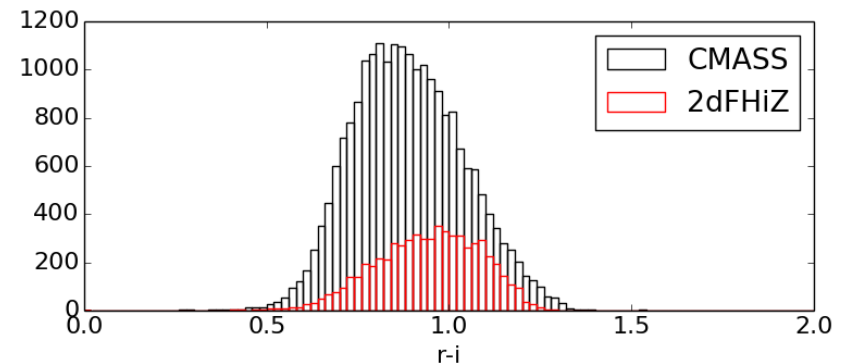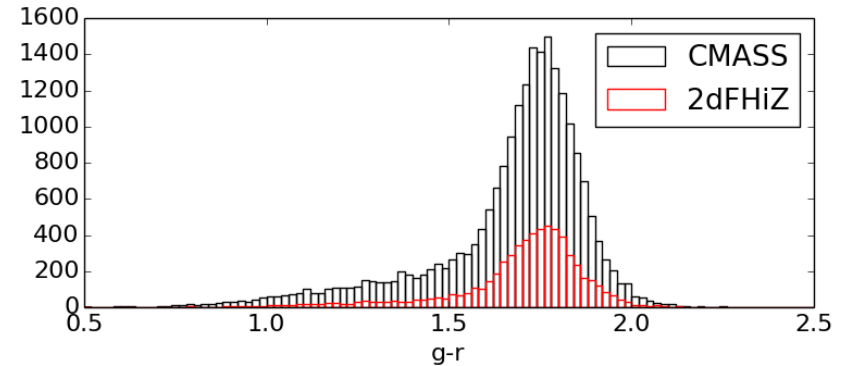
Methods for measuring $\Delta\Sigma(R)$

- My code agrees closely with SWOT (similar methods) and with the Leiden KiDS-GGL pipeline (different method) – although this latter shows some large-scale fluctuations (?)
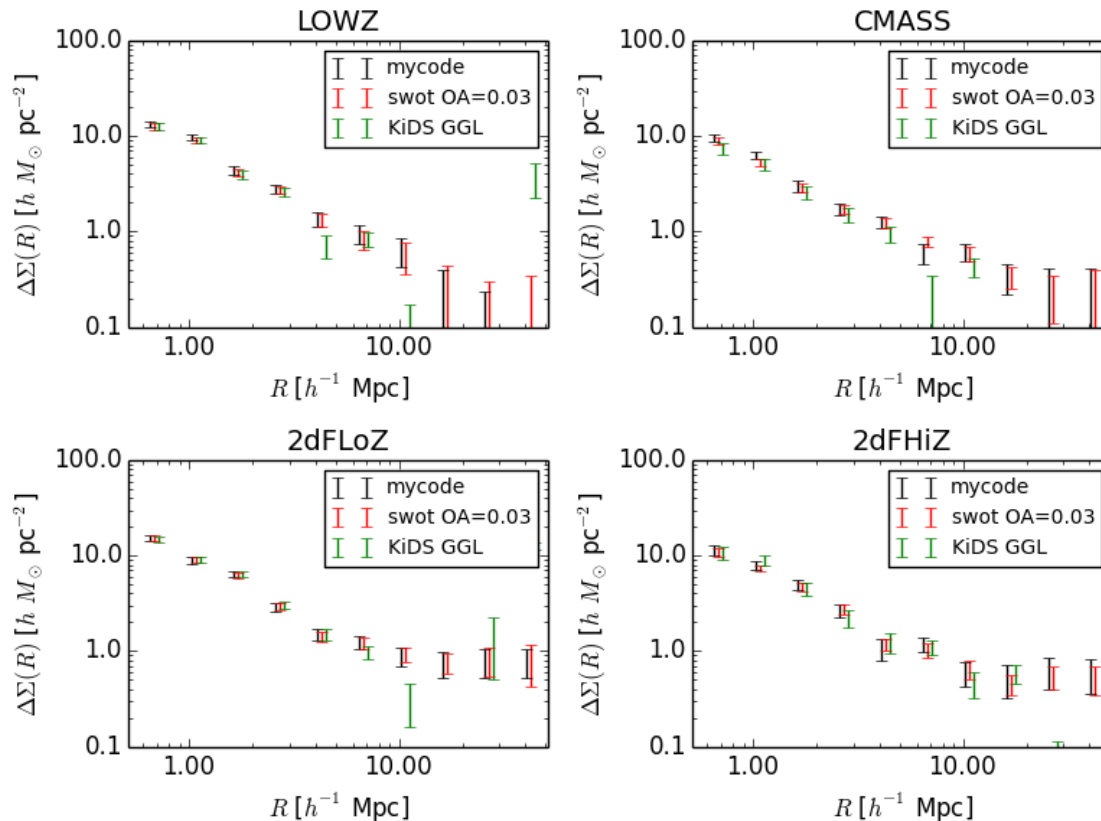
Errors in the $\Delta\Sigma(R)$ measurements

- JK generally agrees with SLICS60 errors on small scales, SLICS60 predicts a smaller error on large scales. I am working on analytic covariance (with Leiden help!)
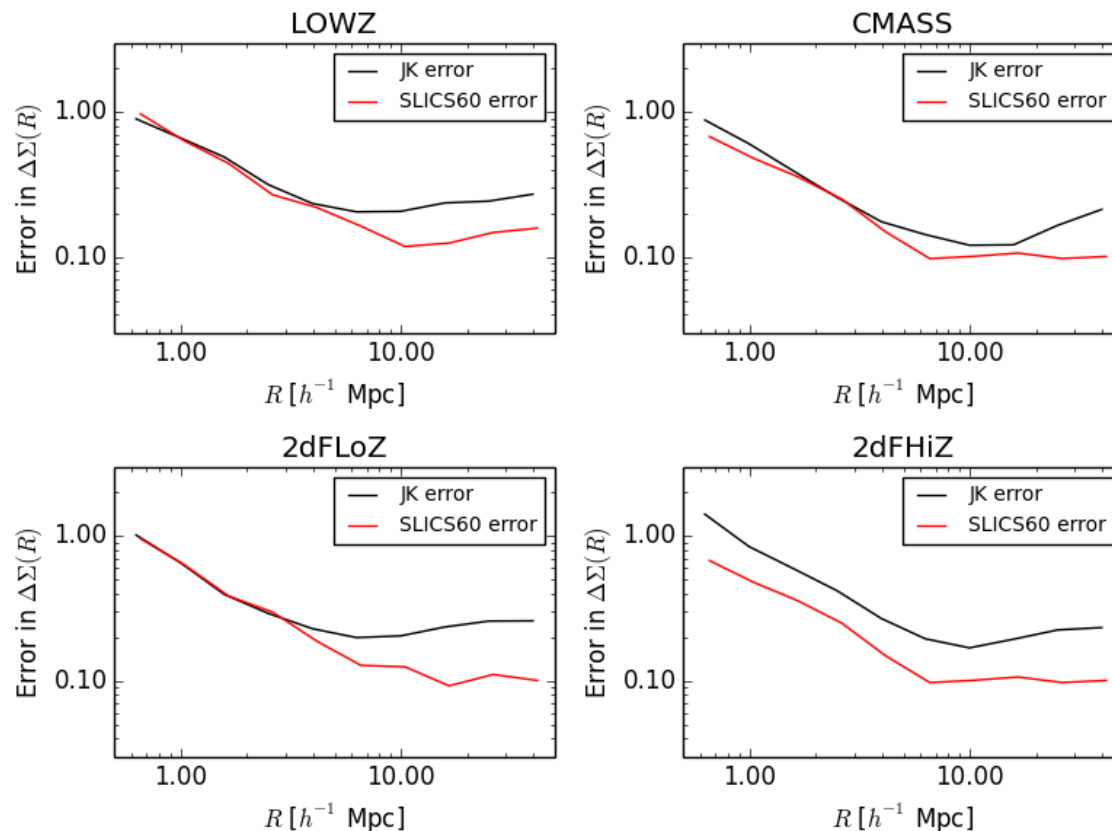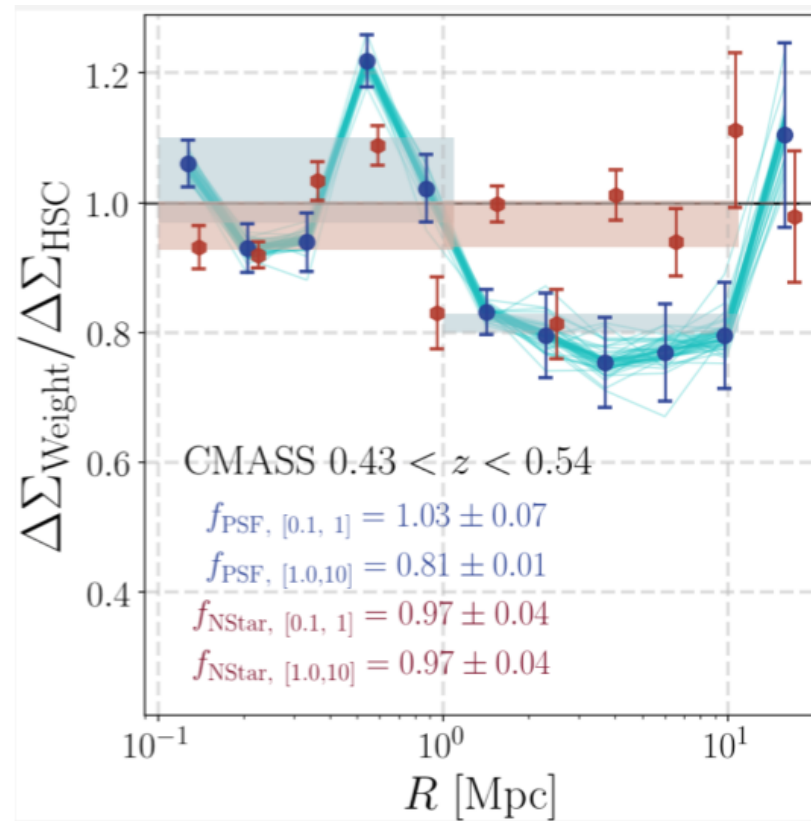
Dependence on seeing?

- Does $\Delta\Sigma(R)$ depend on the seeing (PSF_FWHM) of the target imaging from which BOSS LRGs are selected?

- These plots show $\Delta\Sigma(R)$ for LOWZ/CMASS sub-samples, above and below the median PSF_FWHM

- I find no evidence for a variation of $\Delta\Sigma(R)$ with seeing
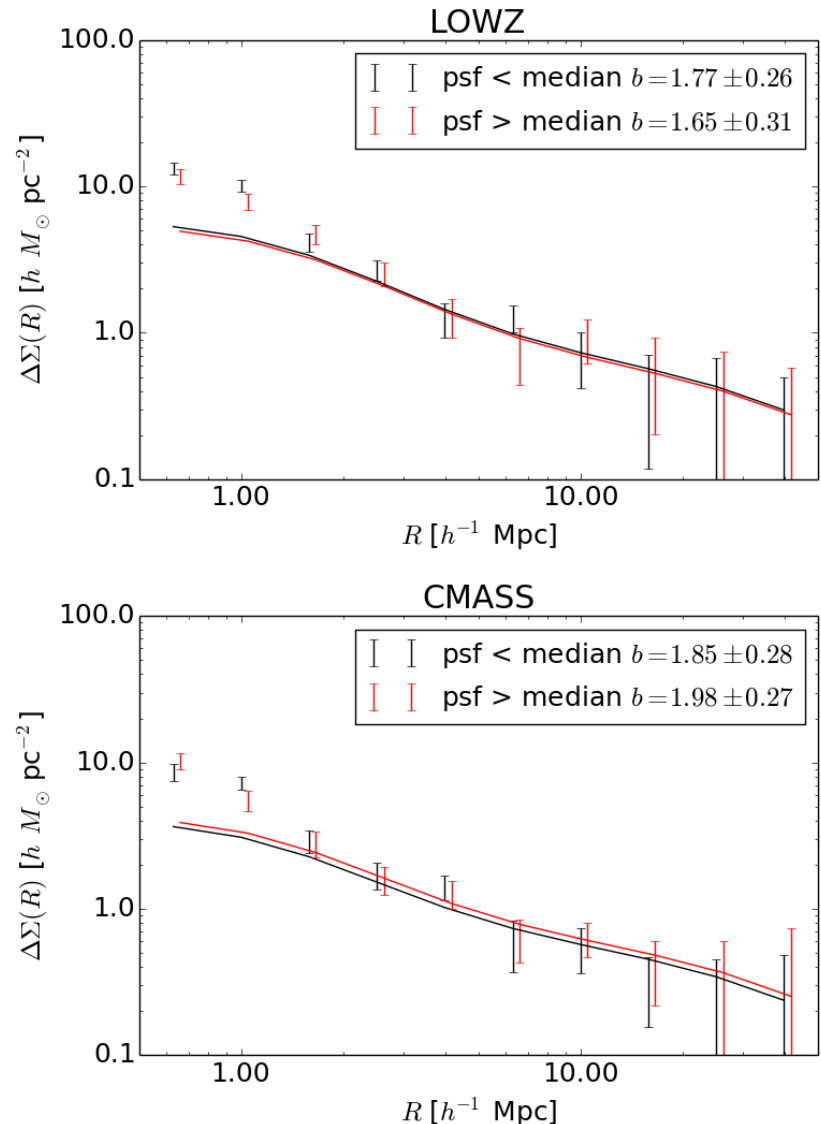
Dependence on seeing?

- I therefore don't reproduce the 20% effect seen in Alex's slide (below). I have not yet succeeded in obtaining Alex's data to test this result further.
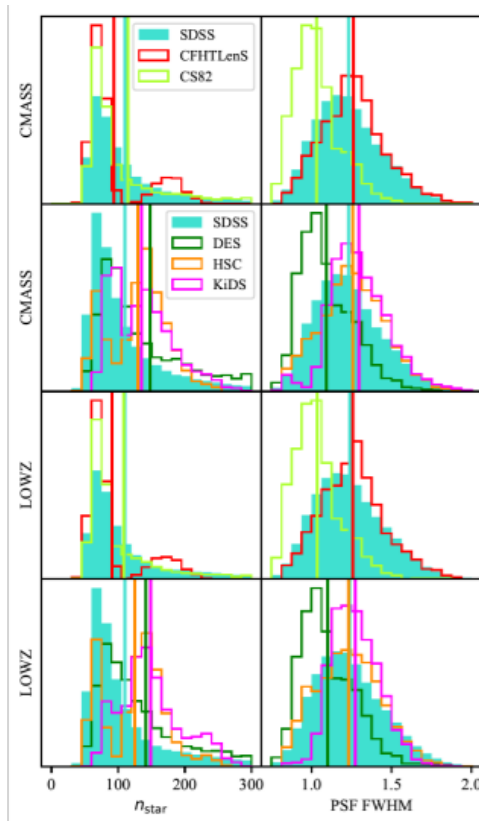
Dependence on seeing?

- In any case, the distribution of PSF_FWHM is only slightly different between the full BOSS area and the K1000 area

Distribution of CMASS PSF_FWHM

Legend:
- ⋯⋯ All data lenses
- ── KiDS1000 data lenses
- ⋯⋯ All random lenses
- ── KiDS1000 random lenses

y-axis: Probability
x-axis: PSF_FWHM in i-band
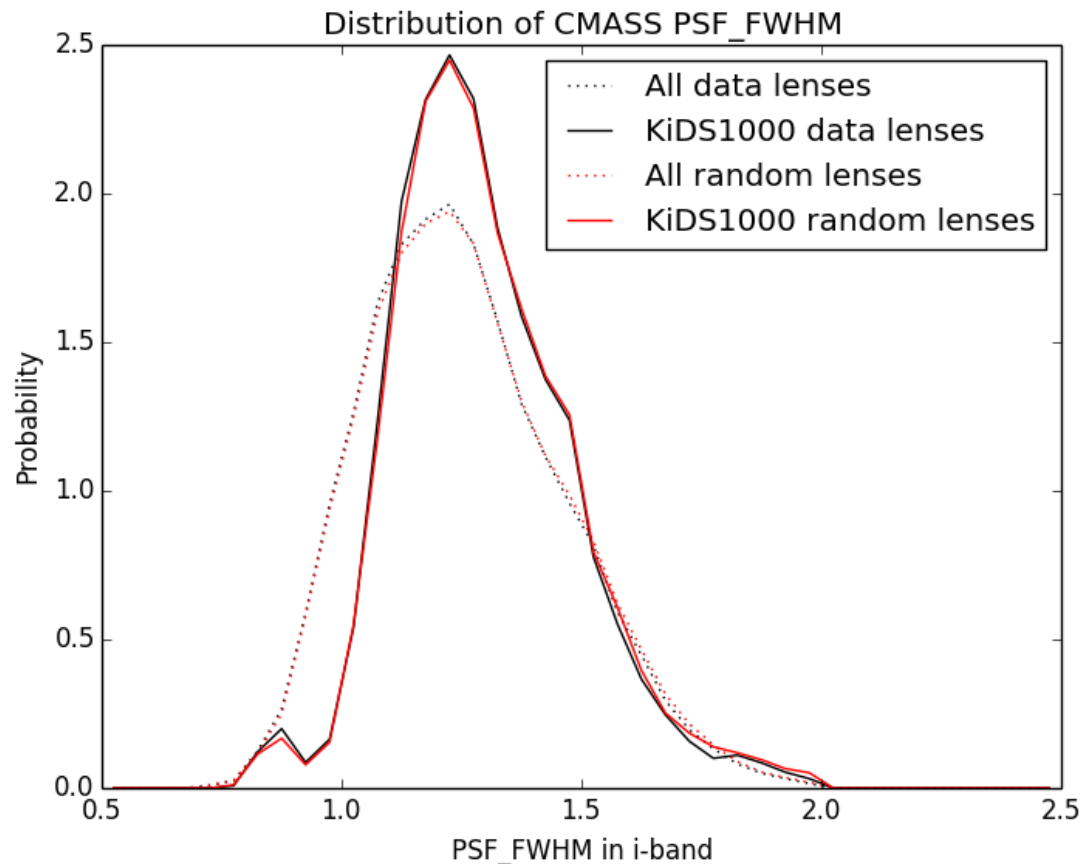
Dependence on BOSS weights?

- BOSS provides various possible galaxy weights

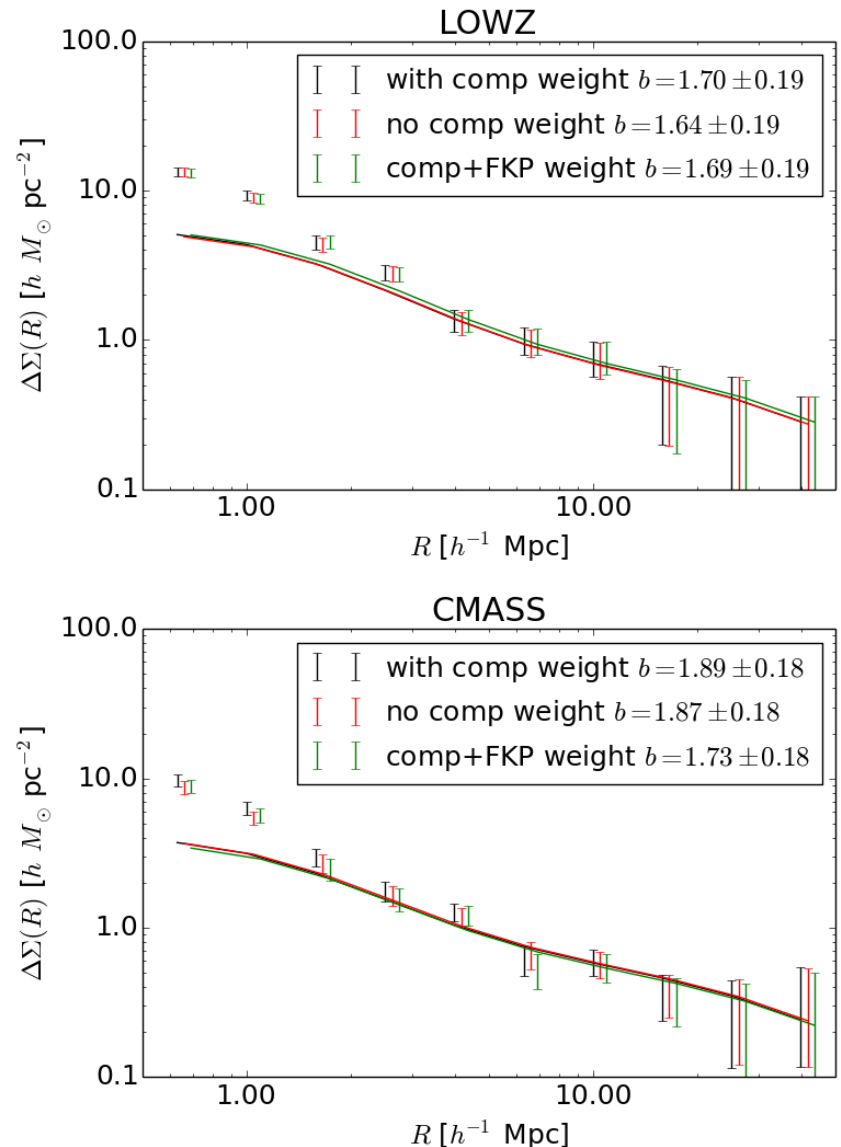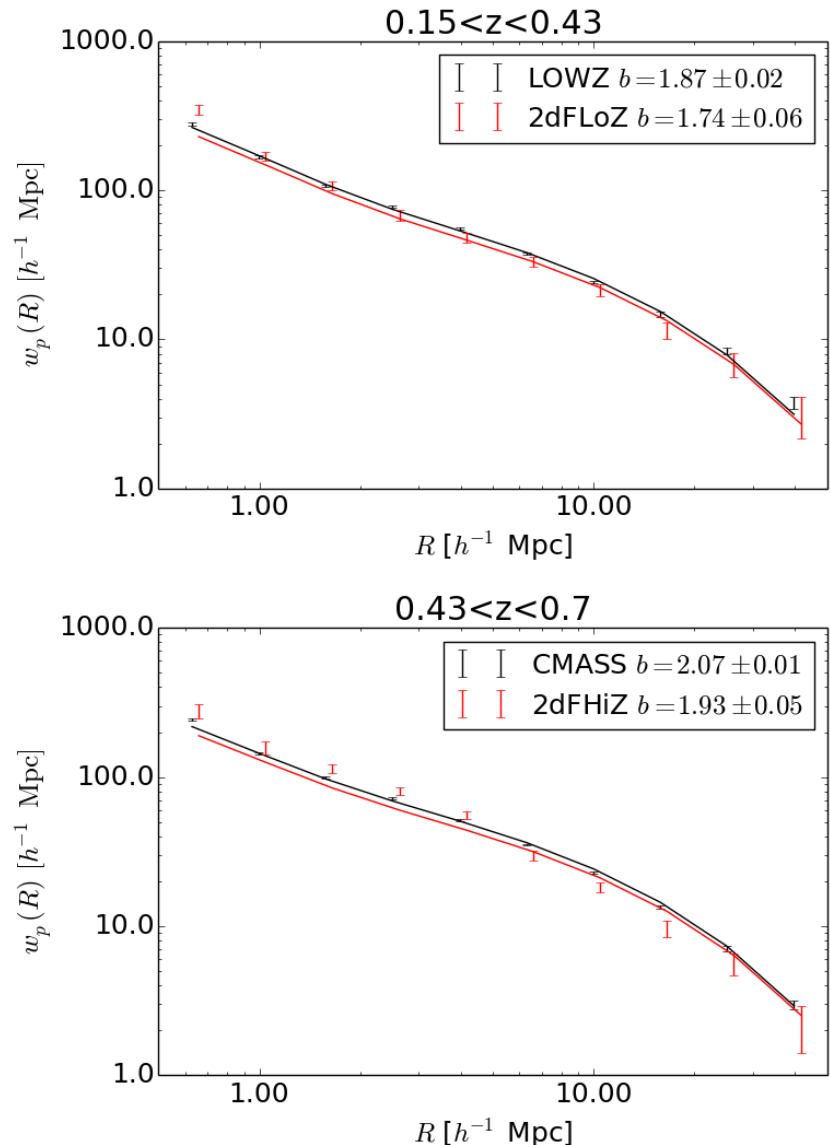- These plots are $\Delta\Sigma(R)$ for LOWZ/CMASS sub-samples, using completeness weights [default case], all weights=1, completeness and FKP weights

- Whether or not we use completeness weights does not have a significant effect on $\Delta\Sigma(R)$

LOWZ

with comp weight $b = 1.70 \pm 0.19$
no comp weight $b = 1.64 \pm 0.19$
comp+FKP weight $b = 1.69 \pm 0.19$

$\Delta\Sigma(R)$ [$h\ M_\odot\ \mathrm{pc}^{-2}$]

R [h^{-1} Mpc]

CMASS

with comp weight $b = 1.89 \pm 0.18$
no comp weight $b = 1.87 \pm 0.18$
comp+FKP weight $b = 1.73 \pm 0.18$

$\Delta\Sigma(R)$ [$h\ M_\odot\ \mathrm{pc}^{-2}$]

R [h^{-1} Mpc]

Effective galaxy bias

- Here are measurements of the projected clustering $w_p(R)$ of BOSS and 2dFLenS (using the whole BOSS NGP region, errors from mock catalogues)

- The smaller errors reveal some more differences in the large-scale clustering amplitude, although this will not affect the intended analysis (since 2dFLenS clustering will not be used)

0.15<z<0.43

LOWZ $b = 1.87 \pm 0.02$
2dFLoZ $b = 1.74 \pm 0.06$

0.43<z<0.7

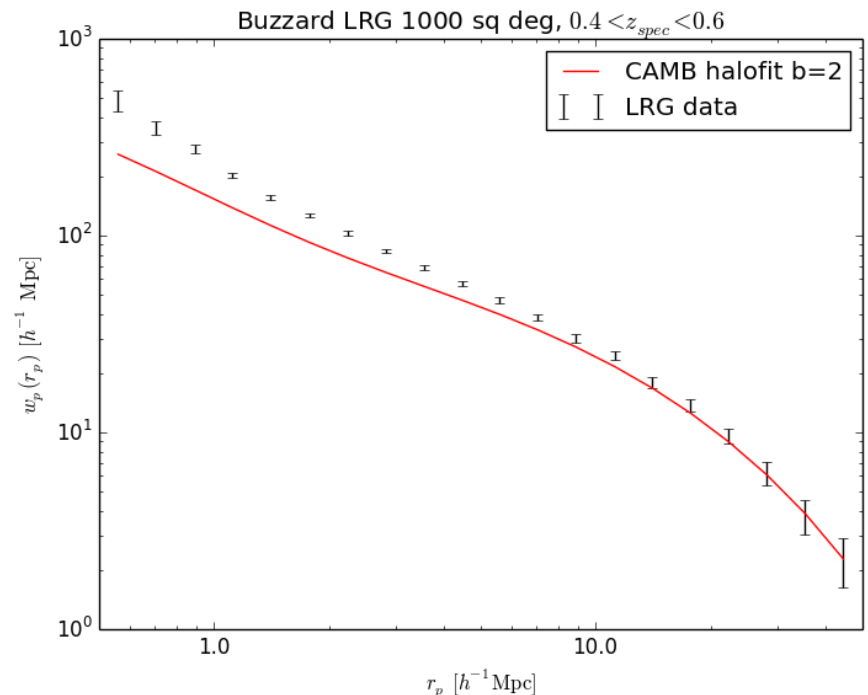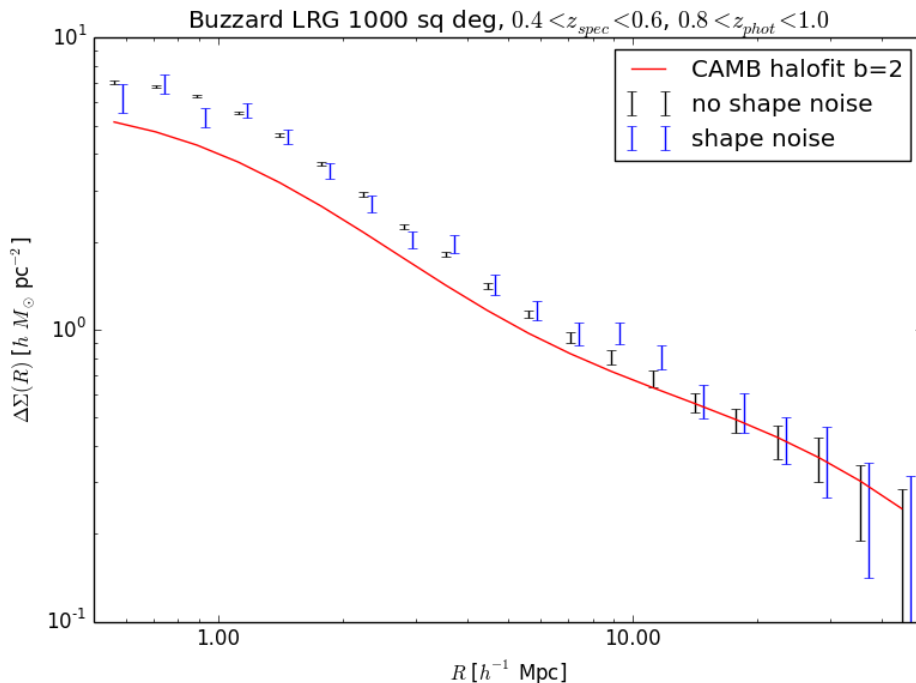CMASS $b = 2.07 \pm 0.01$
2dFHiZ $b = 1.93 \pm 0.05$

Effective galaxy bias

- The key test is whether the same galaxy bias or effective redshift can describe both $\Delta\Sigma(R)$ and the projected clustering $w_p(R)$ for BOSS, here is that comparison:
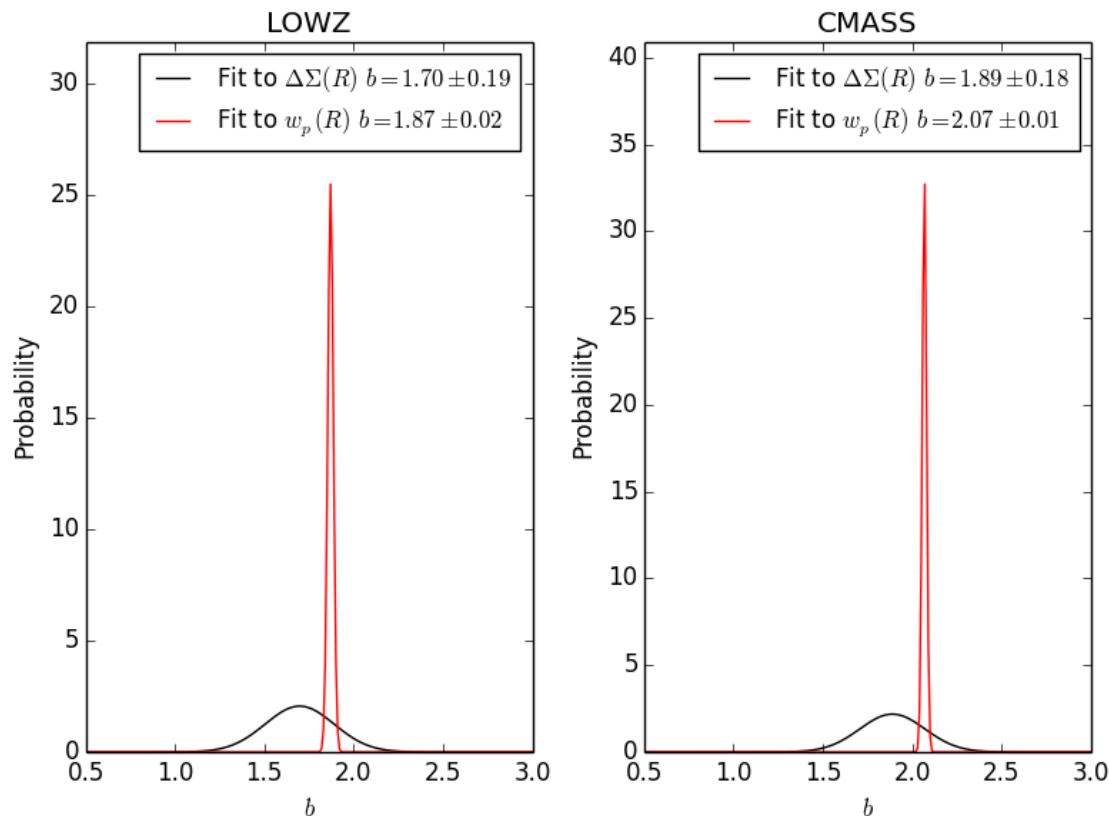
Effective galaxy bias

- The comparison between these bias measurements is acceptable, given the noise in the $\Delta\Sigma(R)$ measurements

- This investigation could be extended using simulations – Buzzard, MICE or SLICS mocks? (example below for Buzzard)

Buzzard LRG 1000 sq deg, $0.4 < z_{spec} < 0.6$, $0.8 < z_{phot} < 1.0$

CAMB halofit b=2 — no shape noise — shape noise

$\Delta\Sigma(R)$ $[h\,M_\odot\,\mathrm{pc}^{-2}]$

R $[h^{-1}\,\mathrm{Mpc}]$

Buzzard LRG 1000 sq deg, $0.4 < z_{spec} < 0.6$

CAMB halofit b=2 — LRG data

$w_p(r_p)$ $[h^{-1}\,\mathrm{Mpc}]$

r_p $[h^{-1}\,\mathrm{Mpc}]$

Summary so far

- KiDS-1000 offers significantly improved overlap with both BOSS and 2dFLenS lenses

- BOSS and 2dFLenS show consistent amplitudes (errors are $\sim 10\%$) of galaxy-galaxy lensing on scales $R > 3\ h^{-1}$ Mpc

- No current evidence in my measurements for a systematic due to PSF_FWHM in the BOSS LRG target selection

- BOSS completeness weights do not have a strong effect

- Same linear bias can describe both $\Delta\Sigma(R)$ and the projected clustering $w_p(R)$ for BOSS (errors are $\sim 10\%$, driven by $\Delta\Sigma$)