eBOSS QSO Mock Challenge

Alex Smith

with Etienne Burtin, Jiamin Hou, Richard Neveux + eBOSS QGC group

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Overview

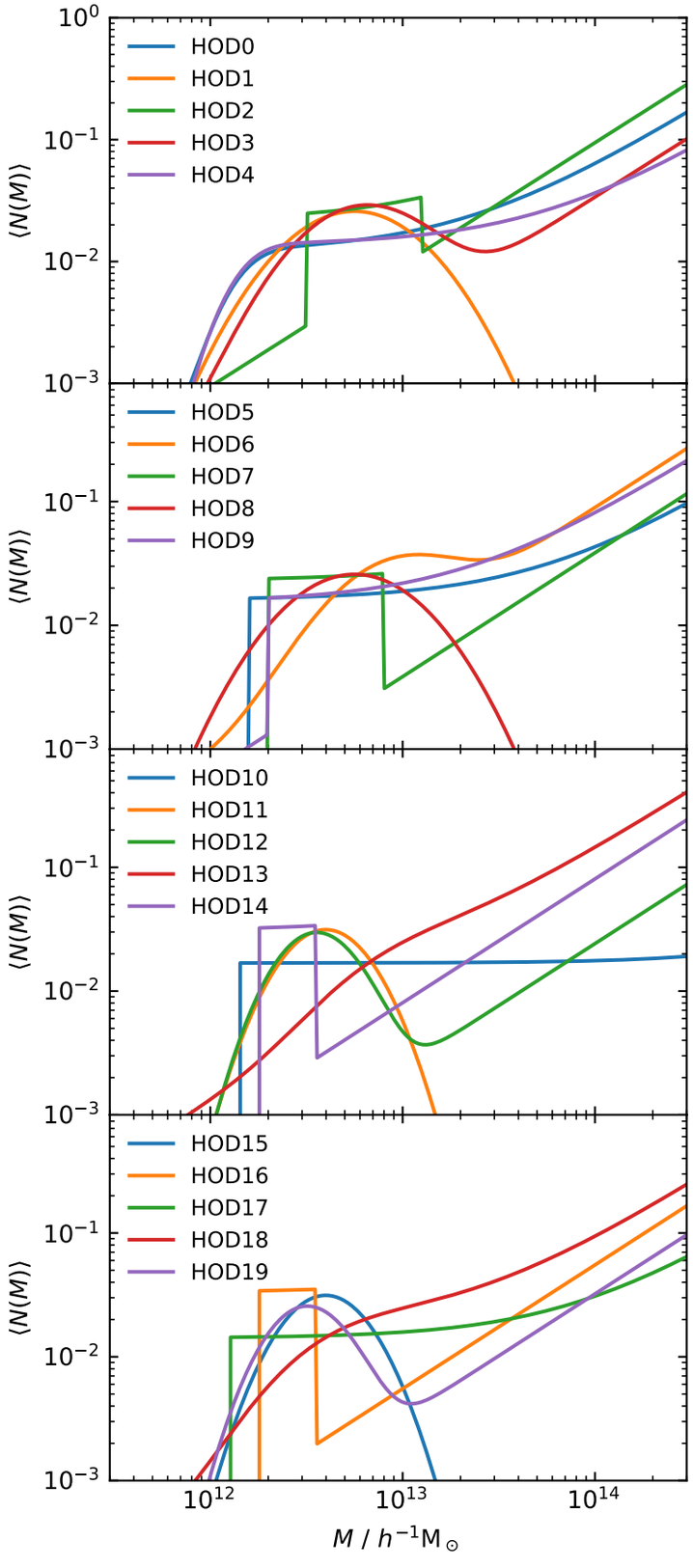
- Aim of mock challenge
- Overview of non-blind mocks
- Blind mocks
  - Mead & Peacock method
  - Validation
- Conclusions

Aim of Mock Challenge

- eBOSS QSO sample: ~300,000 QSOs in redshift range 0.8<z<2.2, covering ~4,000 sq deg
- Validate RSD models used in QSO clustering analysis
  - Can we recover expected $f\sigma_8$, $\alpha_\parallel$, $\alpha_\perp$
  - Estimate modelling systematic error
    - Varying HOD
    - Redshift uncertainty
    - Fiducial cosmology
- Non-blind and blind mocks

Non-blind mocks

- Mocks constructed from OuterRim simulation (3 Gpc/h), WMAP7 cosmology
- Snapshot at z=1.433
- Populated using a wide range of HODs
- HODs tuned to match clustering and number density of data
- 100 realizations of each HOD (QSO duty cycle ~1%)
- Include effects of redshift smearing and catastrophic redshifts
- Analysis done using OuterRim fiducial cosmology



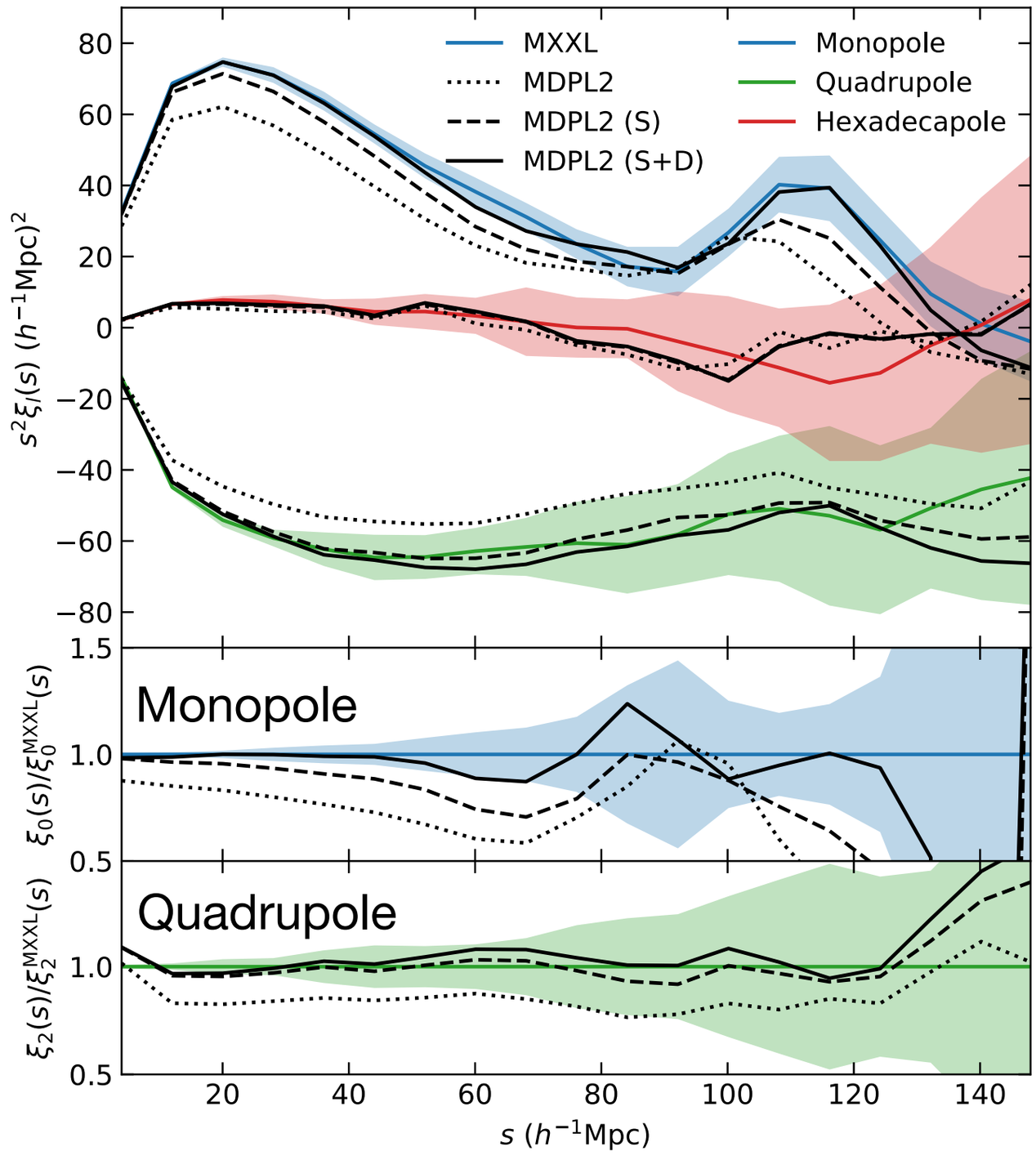
Scaling the Cosmology

- Method of Mead & Peacock 2014 to rescale OuterRim cosmology
- **First part of method**: global scaling of simulation coordinates to reproduce mass function of new cosmology
  - Scale comoving positions $L' = sL$
  - Scale masses $M' = s_{\rm m} M; \quad s_{\rm m} \equiv s^3 \frac{\Omega'_{\rm m}}{\Omega_{\rm m}}$
  - Scale velocities $\mathbf{v}' = s \frac{H' f'_g a'}{H f_g a} \mathbf{v}$
- Snapshot at redshift z rescaled to target redshift z'
- s and z found by matching σ(M)
- **Second part of method**: displace halo positions & velocities using Zel'dovich approximation to reproduce power spectrum
- For positions:

$$\boldsymbol{x}' = \boldsymbol{x} + \delta \boldsymbol{f} \qquad \delta \boldsymbol{f}_{k'} = \left[\sqrt{\frac{\Delta'^2_{\rm lin}(k', z')}{\Delta^2_{\rm lin}(sk', z)}} - 1 \right] \boldsymbol{f}_{k'}$$

Validation of rescaling method

- Rescale MDPL2 simulation (z=1.43) to MXXL (z=1.68)
- These simulations use same FOF halo linking length
- Shaded region is estimate of cosmic variance
- Rescaled MDPL2 clustering is in good agreement with MXXL

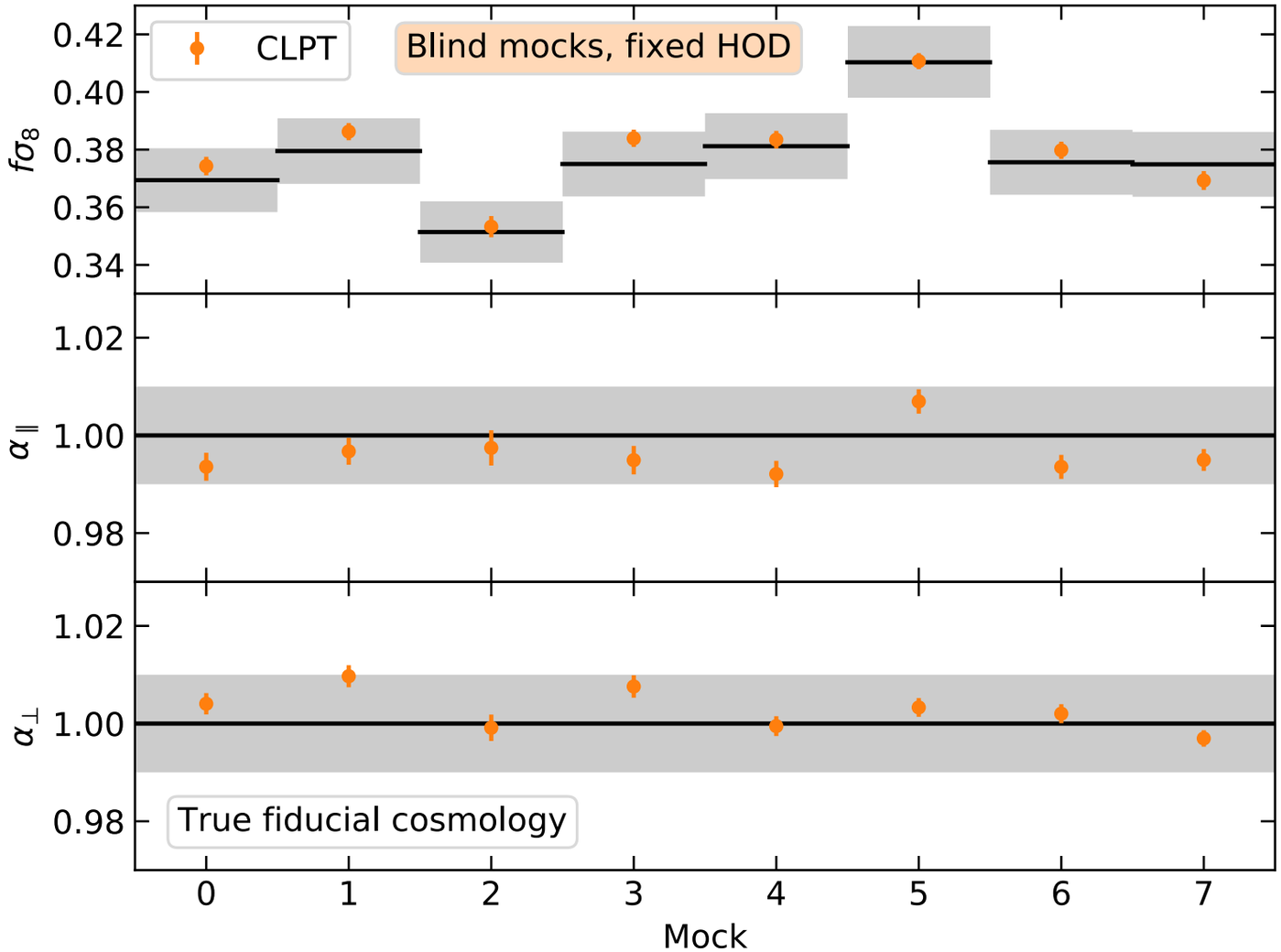


Blind Mocks

- Mead & Peacock method used to rescale OuterRim snapshots either side of z=1.433 to new cosmologies at z=1.433
- Modify $\Omega_{\rm b}$, $\Omega_{\rm cdm}$, h and σ_8 from OuterRim values by generating random numbers from Gaussian distribution
- Find n_s needed for z to match snapshot z when rescaling
- Shifts in cosmological parameters of the order of 5%
- Populate with HODs from non-blind mock challenge
- Python implementation of Mead & Peacock method on GitHub https://github.com/amjsmith/rescale-cosmology

Blind Mocks

- Rescaling method validated using set of mocks with fixed HOD
- Analysed using CLPT model, using rescaled cosmology as fiducial cosmology
- Precision of $f\sigma_8$, $\alpha_\parallel$, $\alpha_\perp$ measurements consistent with non-blind mocks
- For mock challenge, the mocks are analysed using OuterRim fiducial cosmology



Conclusions

- eBOSS QSO mock challenge aims to validate RSD models and estimate systematic errors
- Non-blind mocks test HOD, redshift uncertainty
- Blind mocks test assumption of fiducial cosmology
- Mead & Peacock method used to rescale OuterRim cosmology to create blind mocks
- We have validated the Mead & Peacock method
- Blind and non-blind results are combined to estimate a total modelling systematic error.
- For the models we tested, conservative modelling errors:
  3.0% in $f\sigma_8$ 1.2% in $\alpha_\parallel$ 0.8% in $\alpha_\perp$