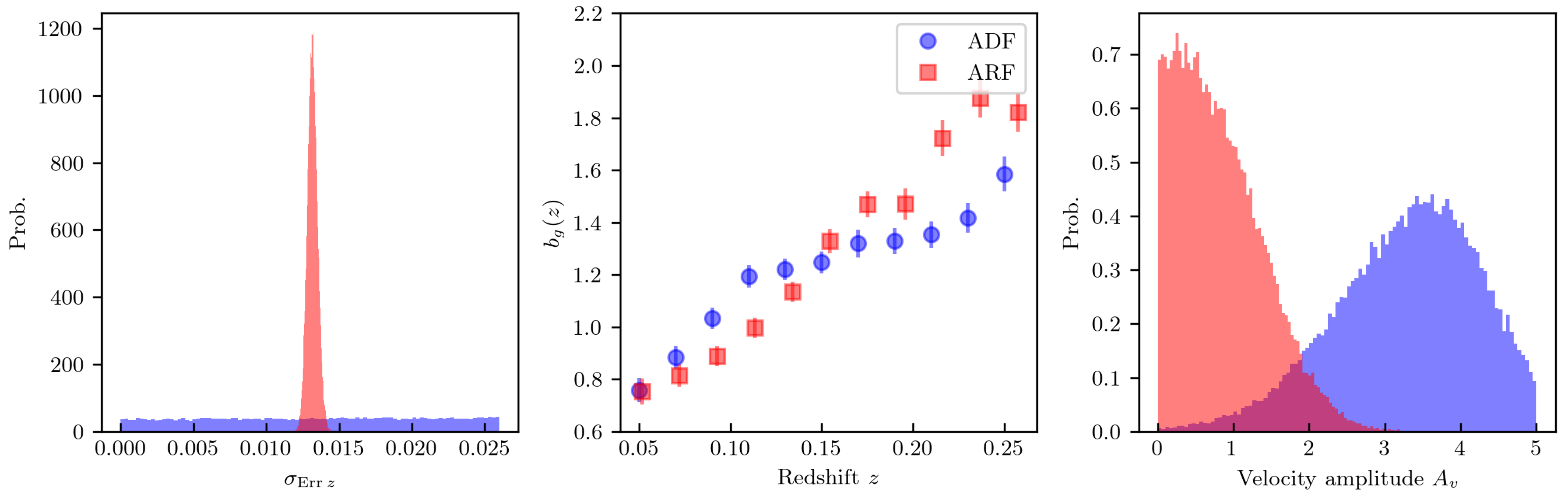
GOBIERNO DE ESPAÑA | MINISTERIO DE CIENCIA E INNOVACIÓN

Universidad de La Laguna

EXCELENCIA SEVERO OCHOA

Digging for cosmological constraints out of high odds J-PLUS DR3 galaxies



Carlos Hernández-Monteagudo (IAC/ULL) + CEFCA

(Antonio HC, Andrés del Pino, Carlinhos, …) and J-PAS LSS

(Rodrigo von Martens, Valerio, Miguel, …)

Euclid CMB-X SWG **Milano, October 22nd 2023**

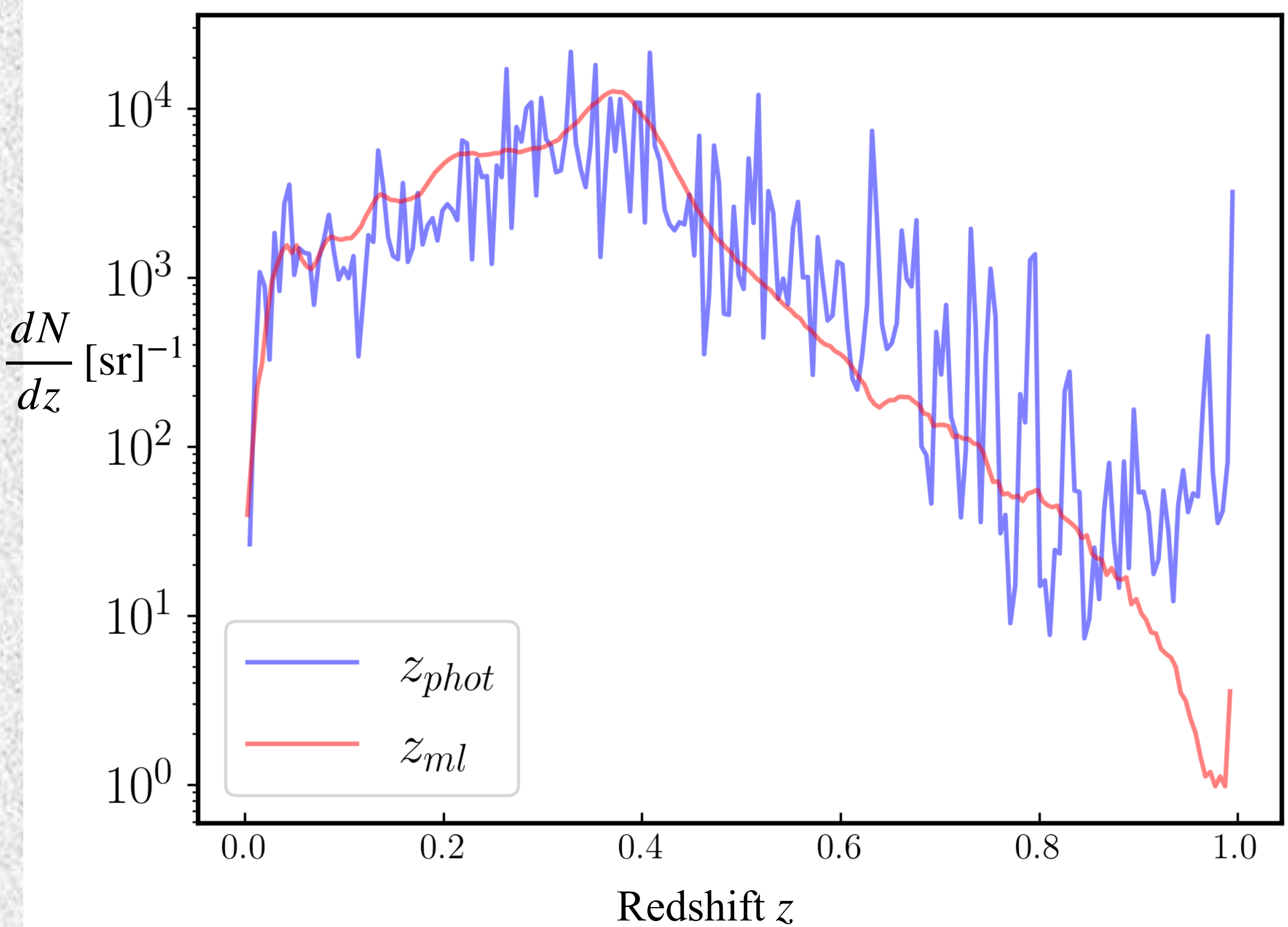
Outline

- The *r<21, odds>0.8* peculiar sample: dN/dz, and impact level from additive and multiplicative systematics
- Tomography from *z=0.05* up to *z=0.25* with 2D clustering (**ADF**) and angular redshift fluctuations (**ARF**)
- Modeling data in the deep non-linear regime with linear theory: the reference of the ***MICE*** mock catalogue
- Comparison with J-PLUS DR3. Tomographic constraints on the bias, peculiar velocities and lensing of the CMB

APM = Andrés del Pino Molina's galaxy catalog
RvM = Rodrigo von Marten's galaxy catalog

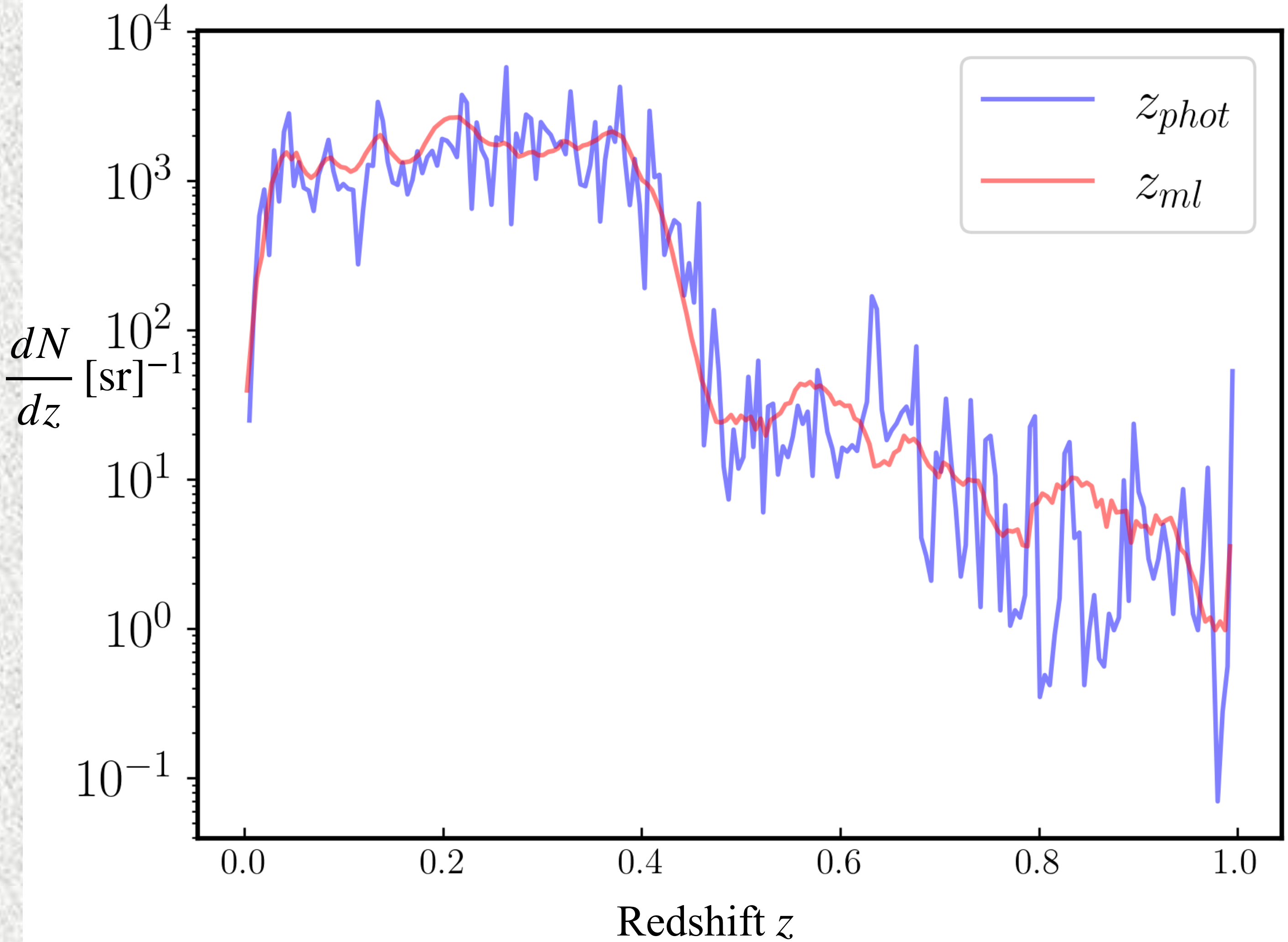
About ~2,800 sq.deg

r<21, odds>0.1, APM



APM = Andrés del Pino Molina’s galaxy catalog
RvM = Rodrigo von Marten’s galaxy catalog

r<21, odds>0.4, APM



APM = Andrés del Pino Molina's galaxy catalog
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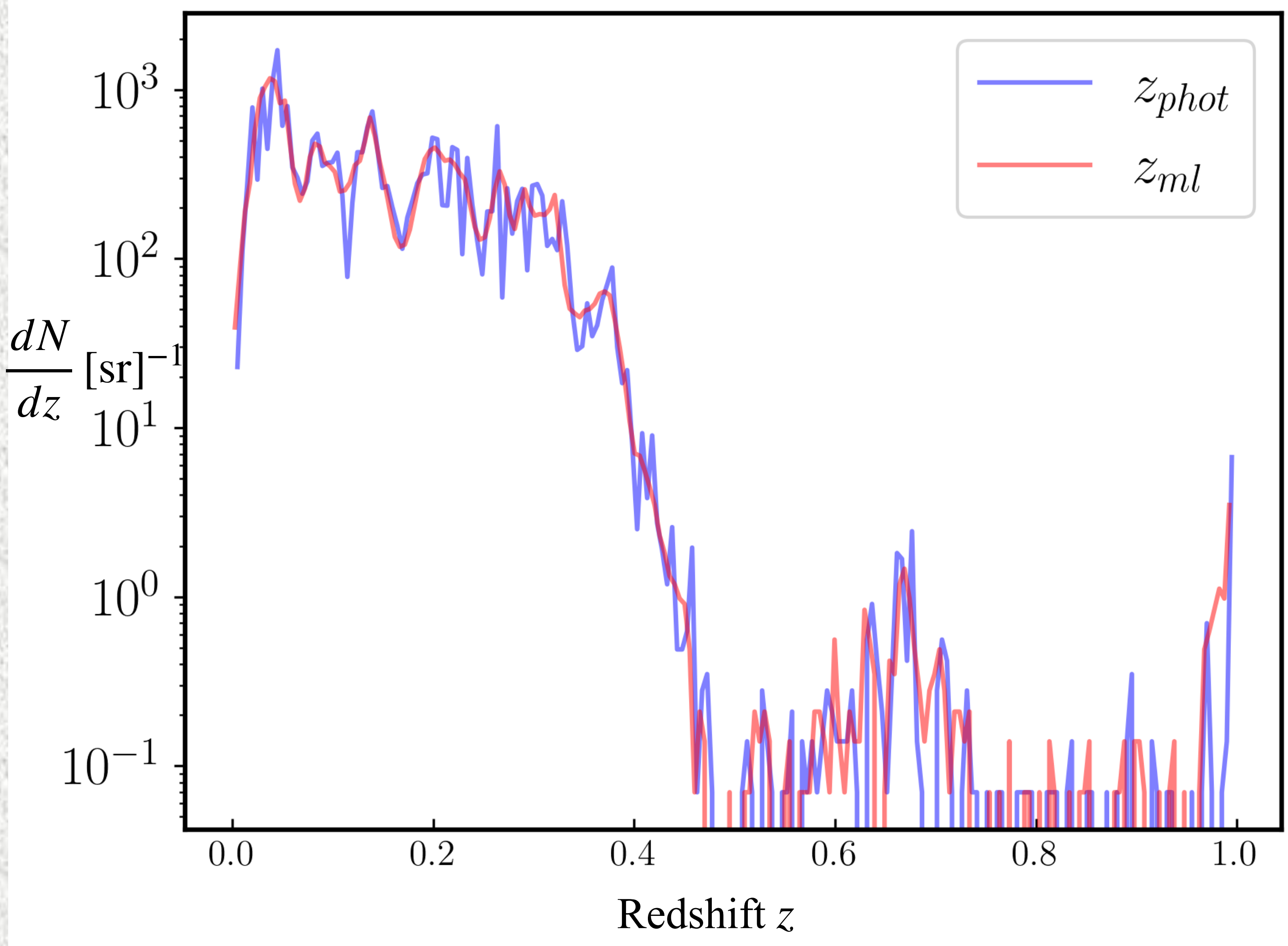
r<21, odds>0.8, APM



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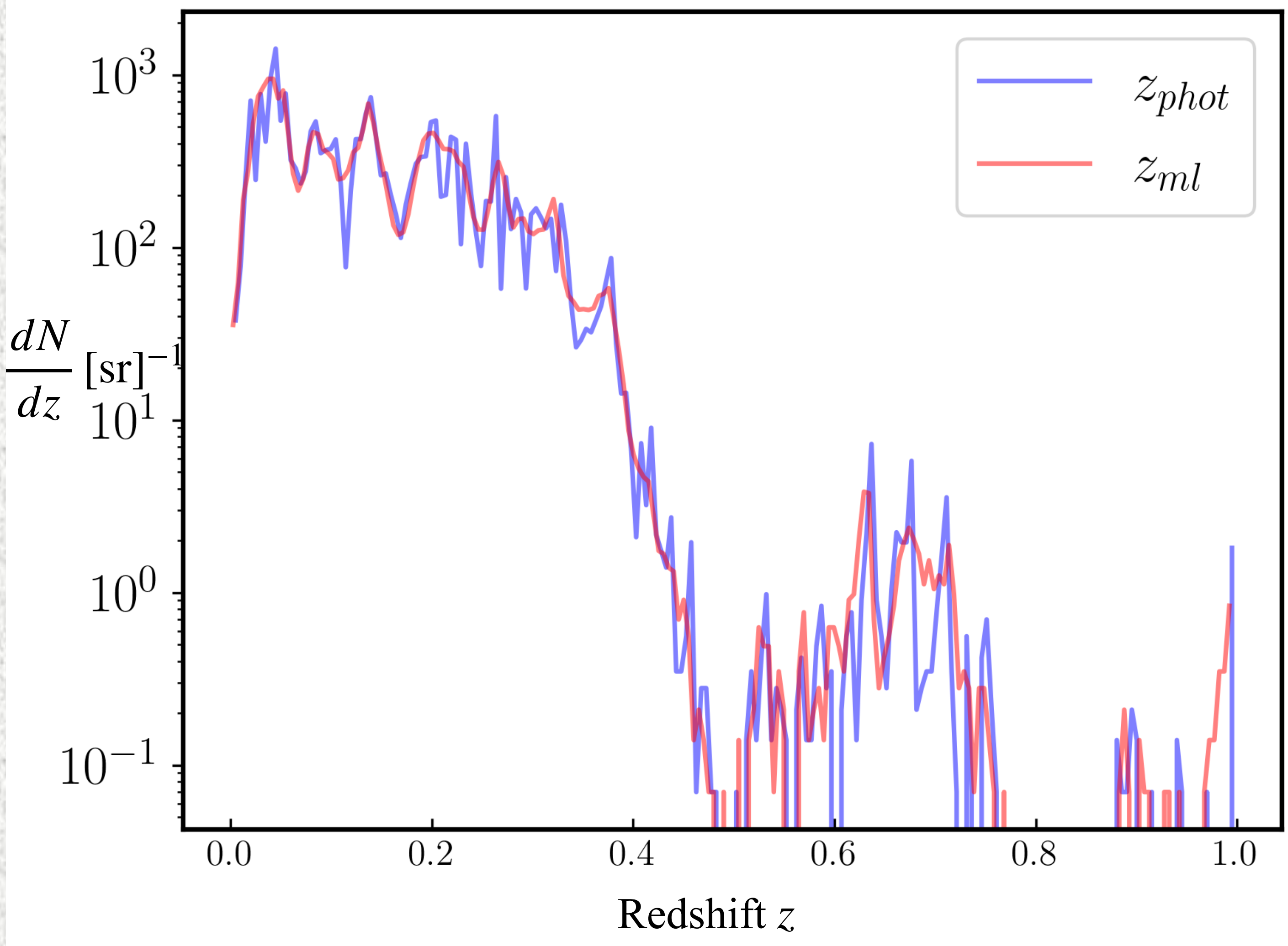
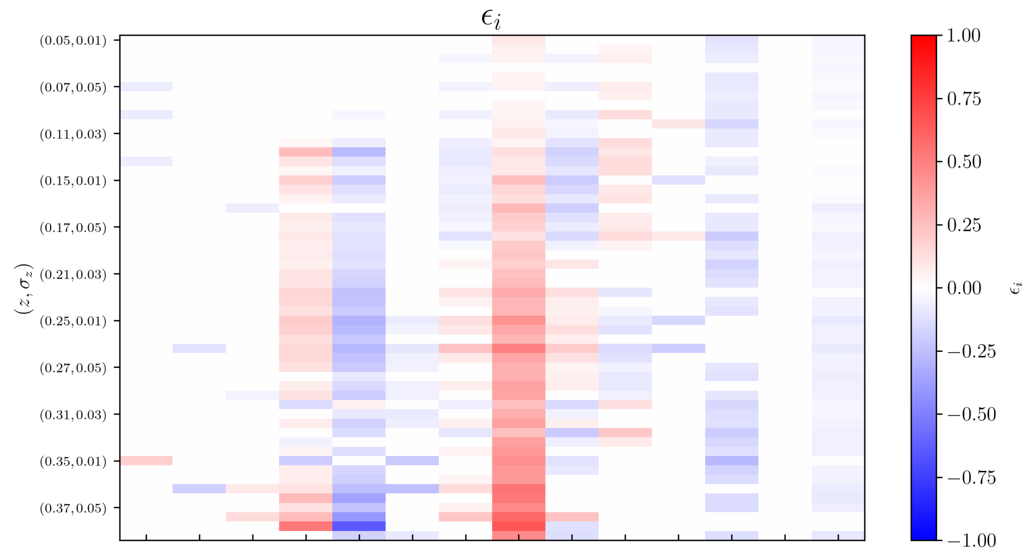
r<21, odds>0.8, RvM





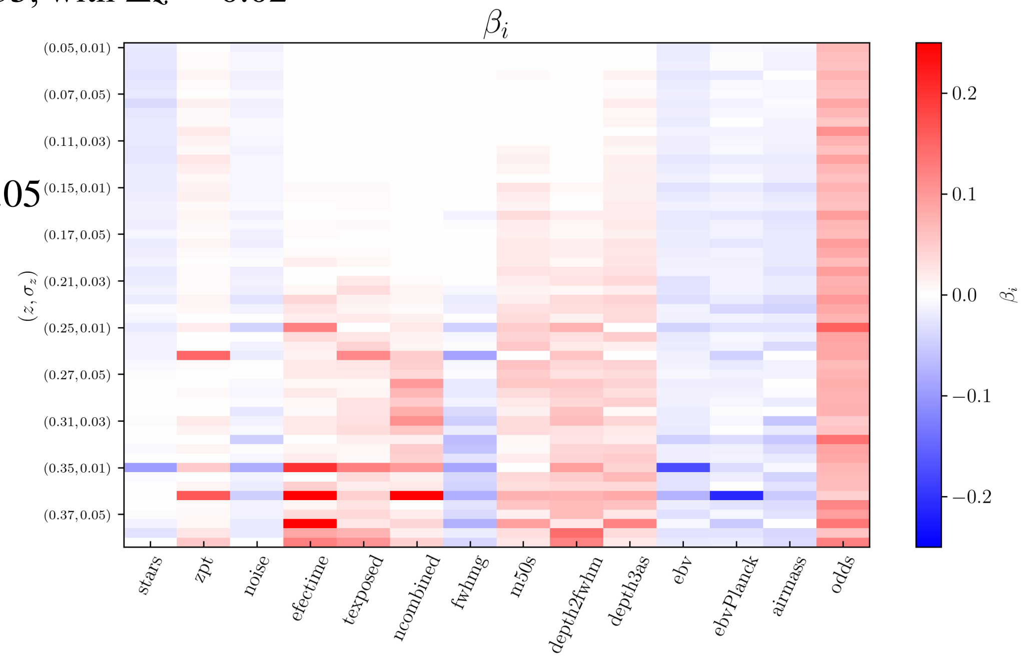
APM TOMOGRAPHY

* 15 redshift shells from $z = 0.05$ up to $z = 0.35$, with $\Delta z = 0.02$

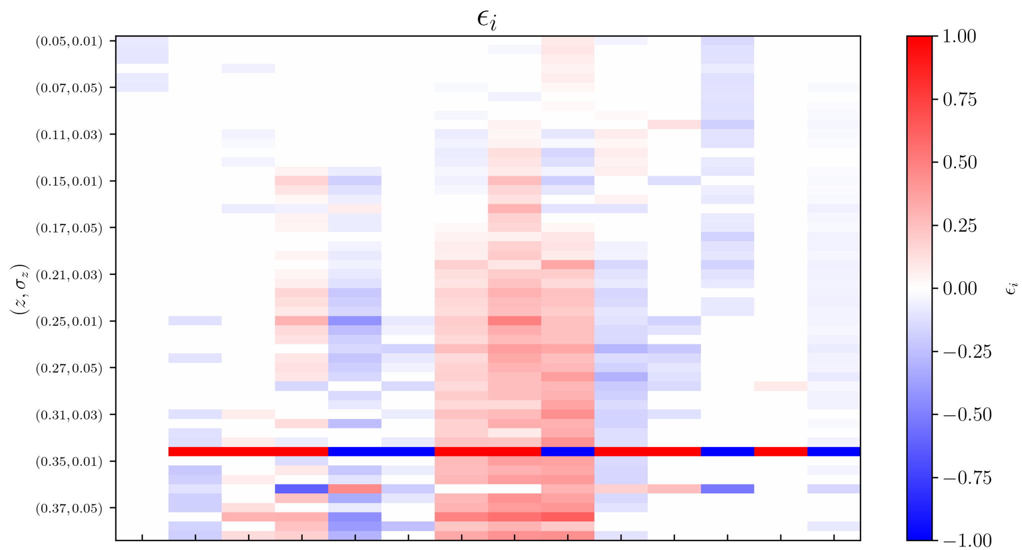
* $W(z) = \dfrac{dN}{dz} \times \exp - (z - z_{\rm obs})^2/(2\sigma_z^2)$

* 3 different Gaussian widths: $\sigma_z = 0.01, 0.03, 0.05$

$$n_g^{\rm obs}(\hat{n}) = \left(n_g(\hat{n}) + \vec{\epsilon} \cdot \vec{\mathbf{M}}\right)\left(\vec{\beta} \cdot \delta \vec{\mathbf{M}}\right)$$



RvM TOMOGRAPHY



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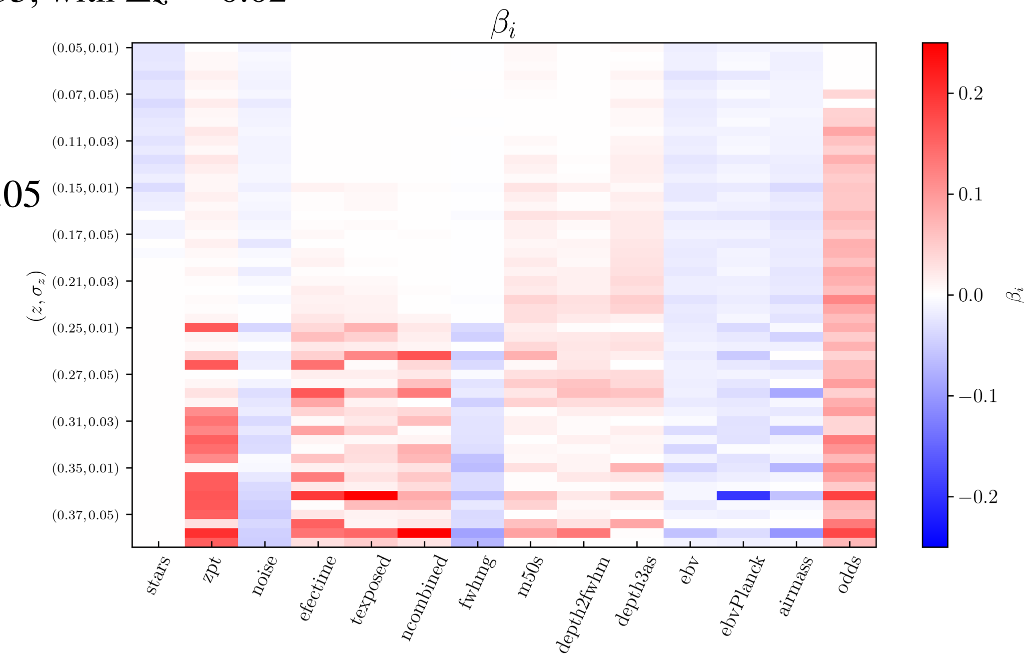
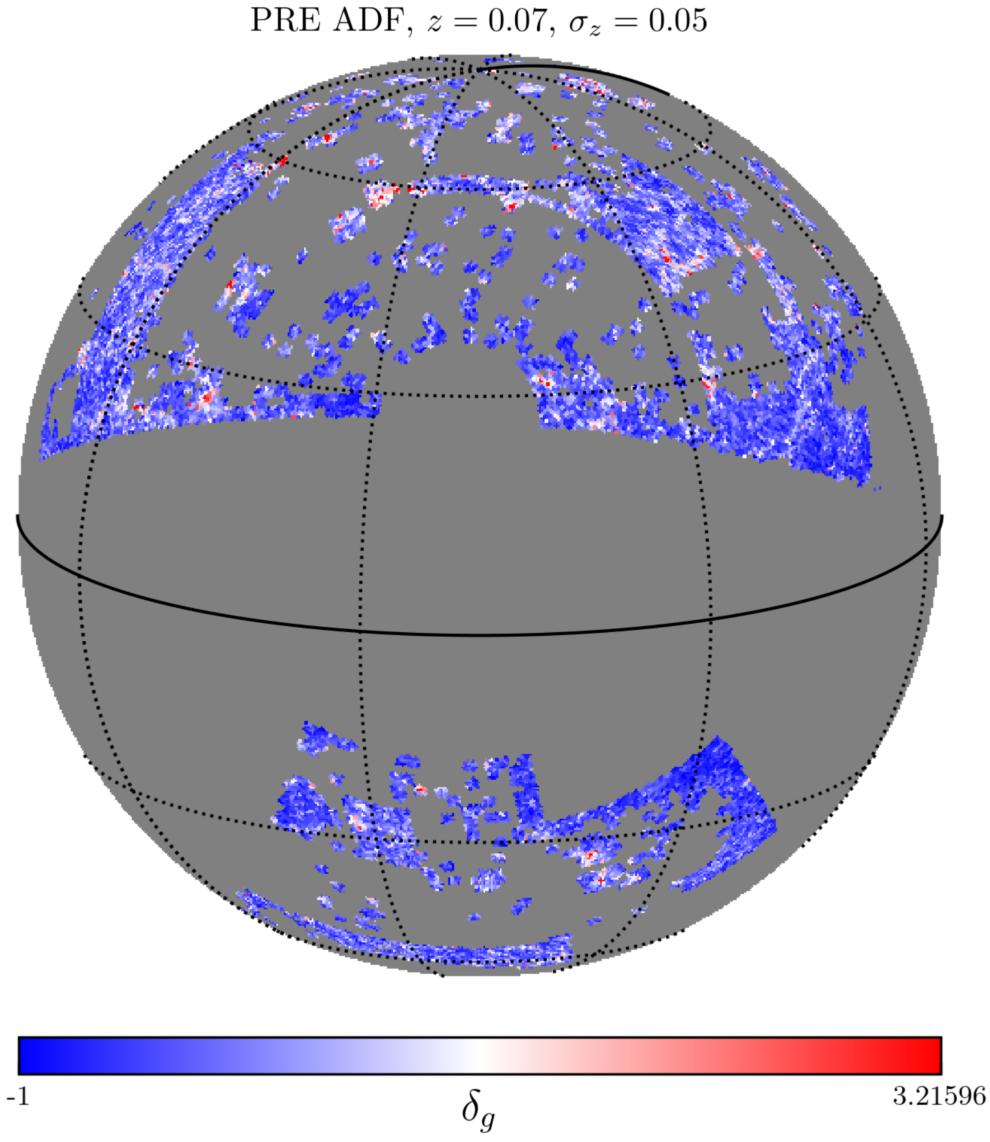
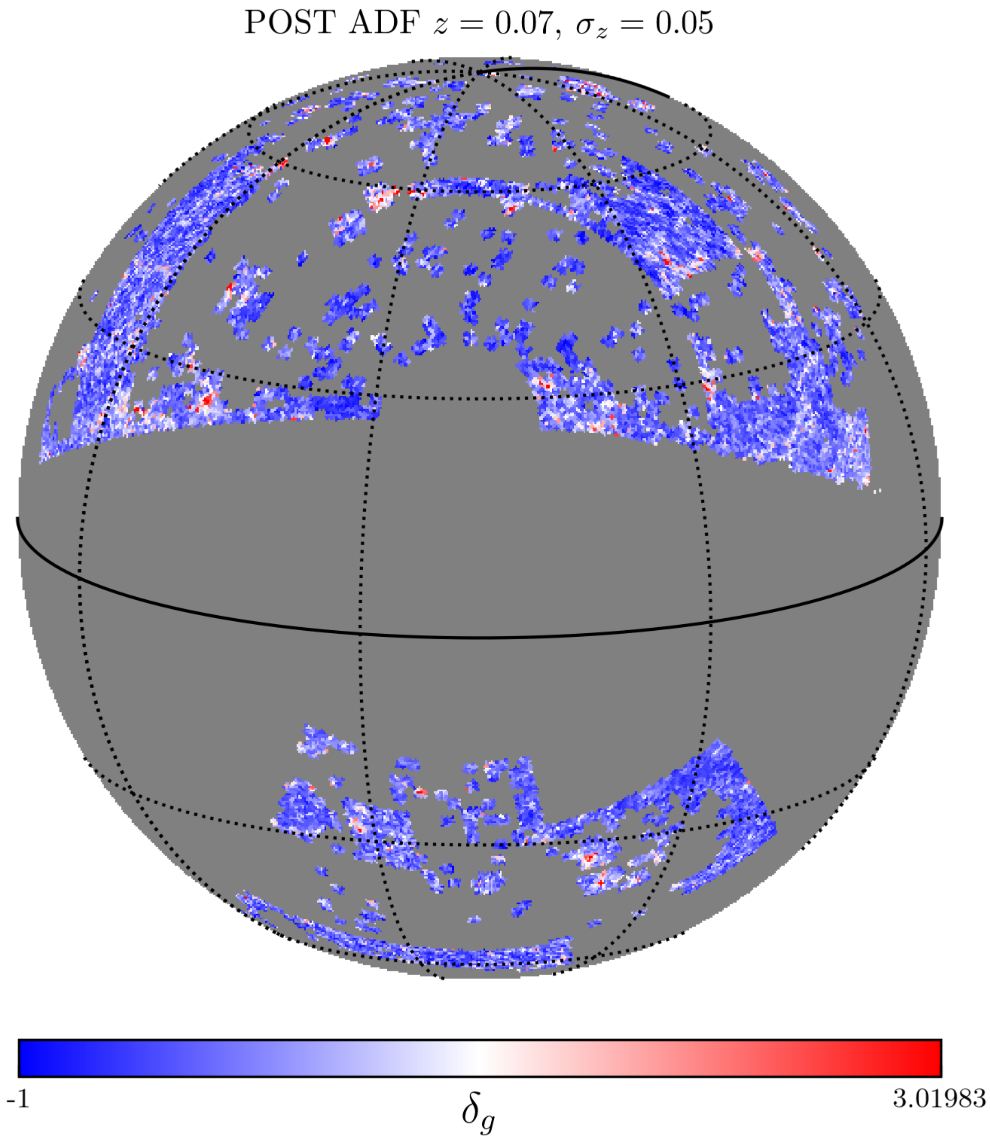


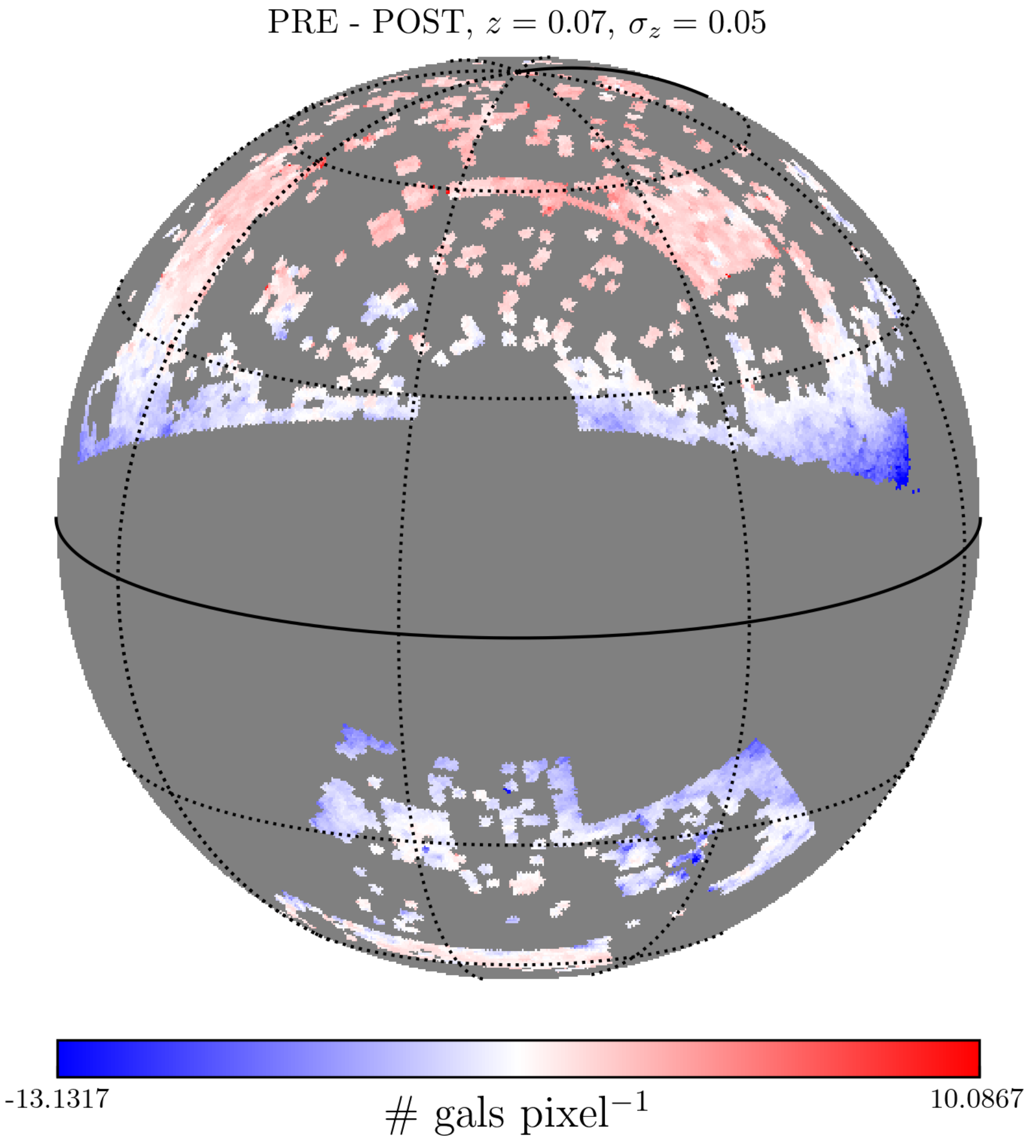
RvM



RvM

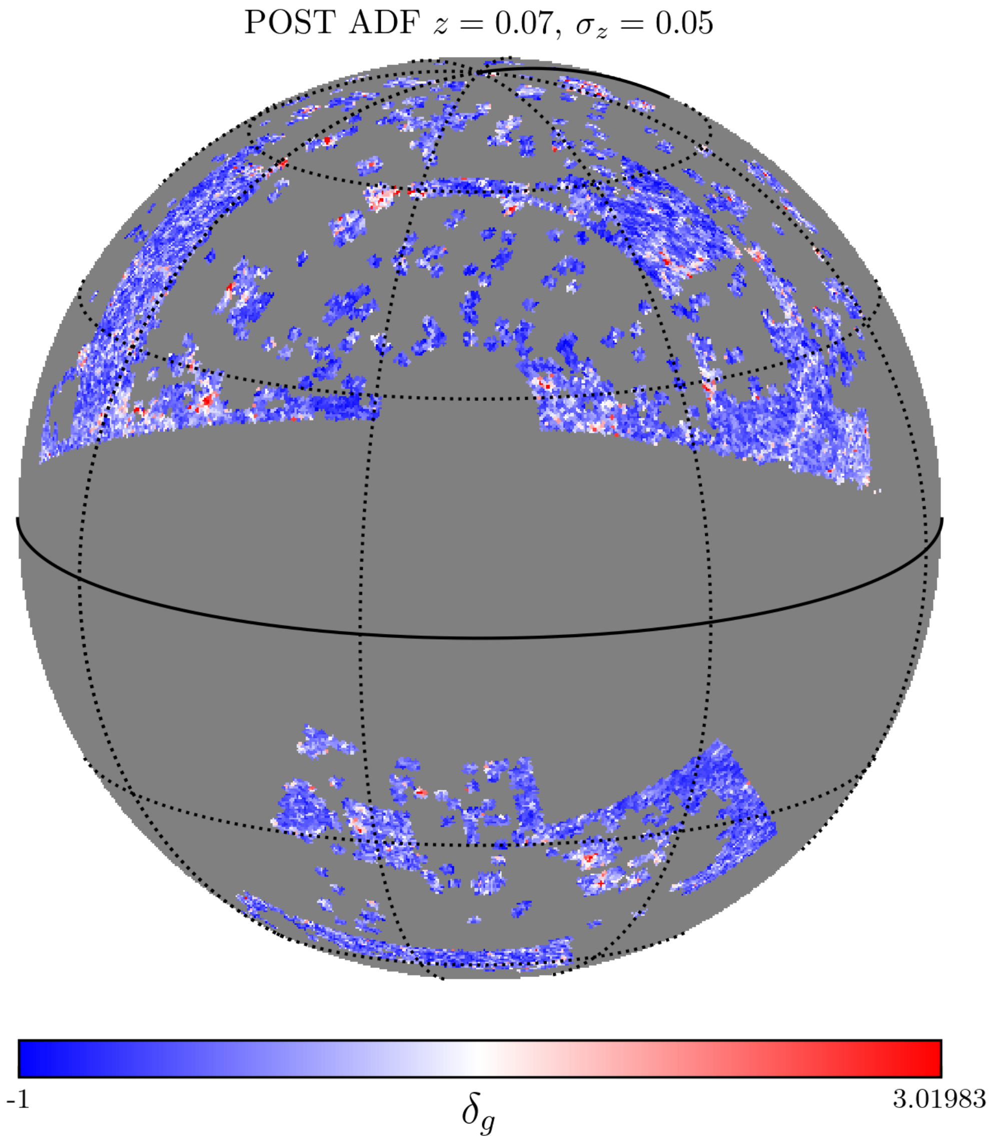


RvM

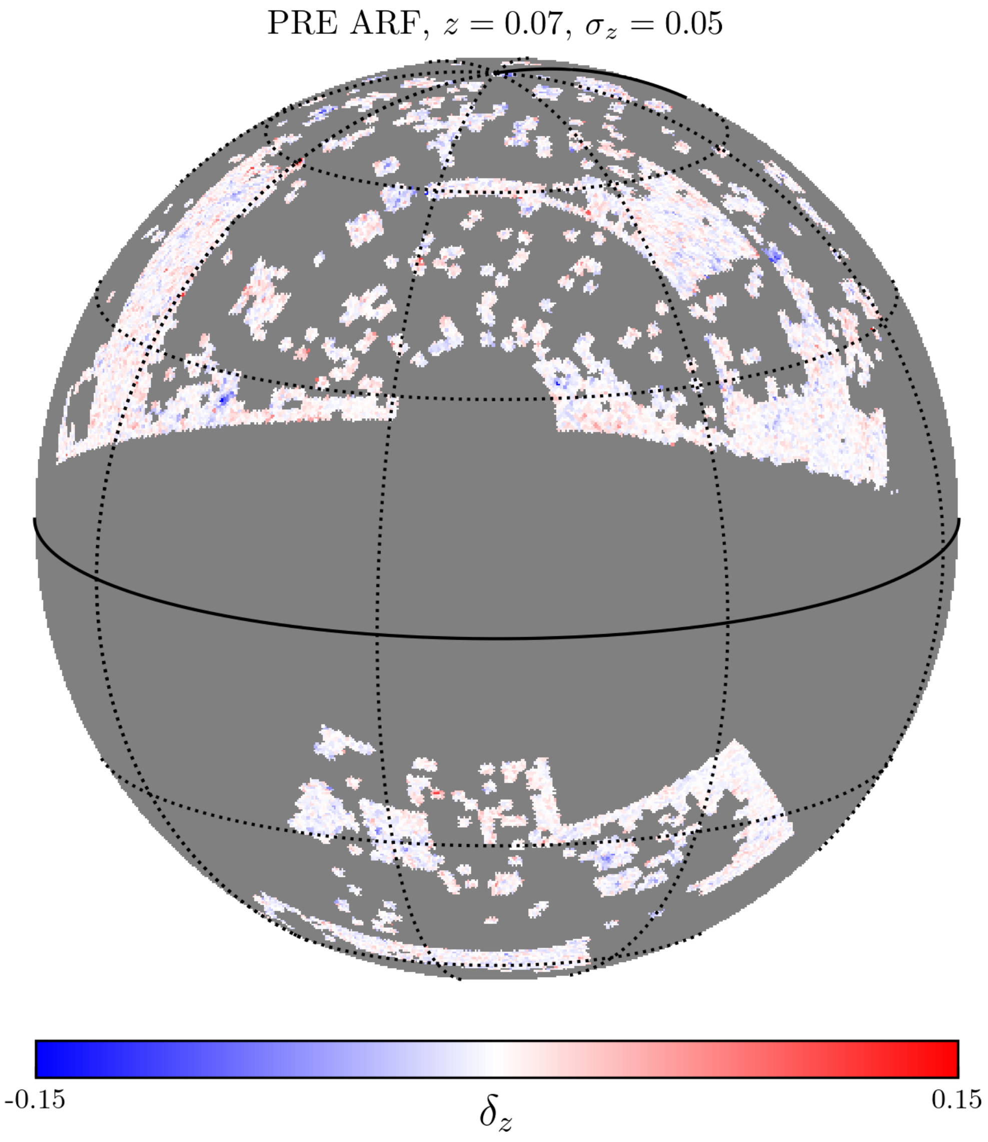


2D clustering, source counts in footprint, angular density fluctuations (ADF)

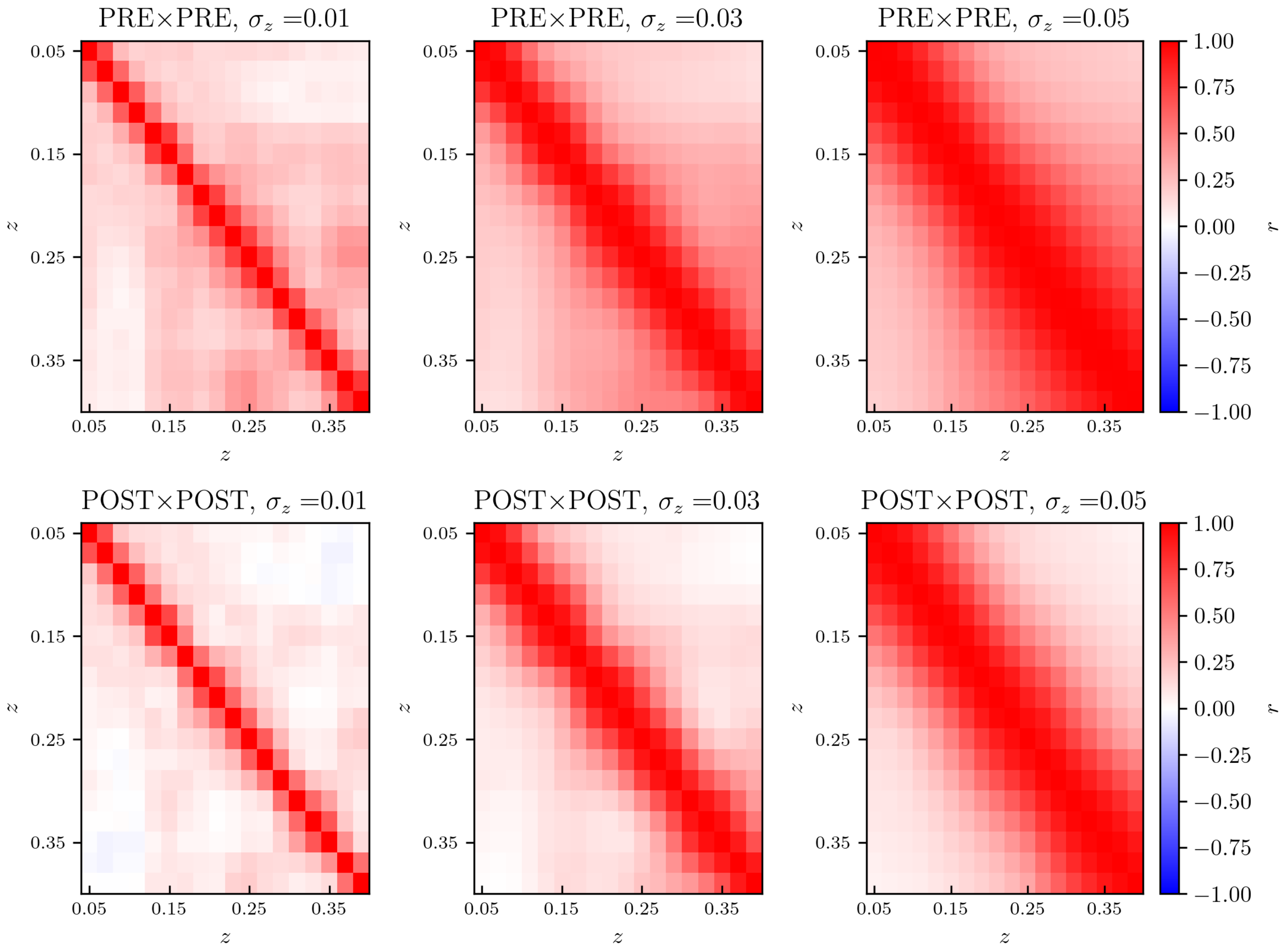
RvM



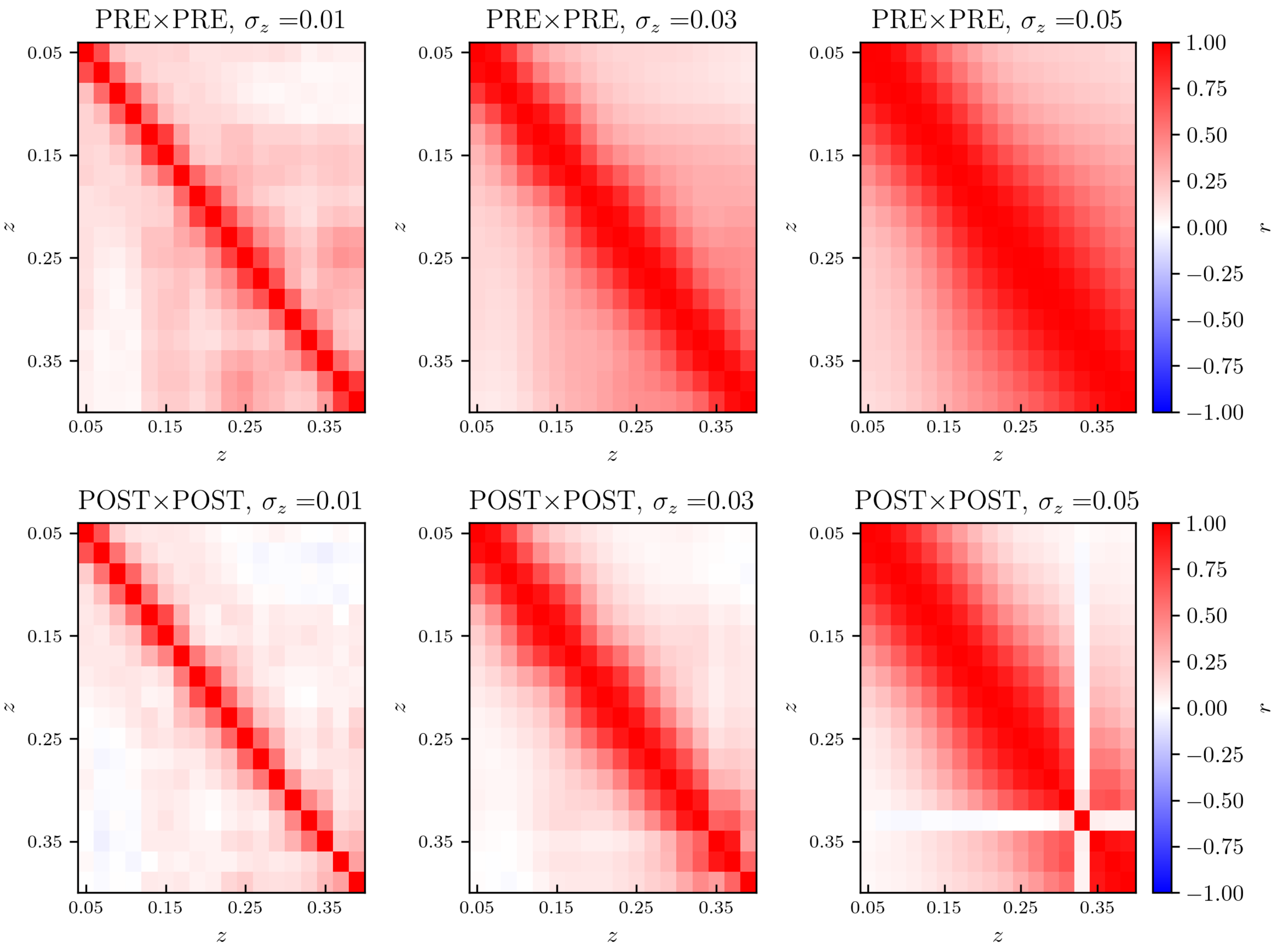
Angular redshift fluctuations (ARF)
(Under any given redshift shell, much more Gaussian observable) **RvM**



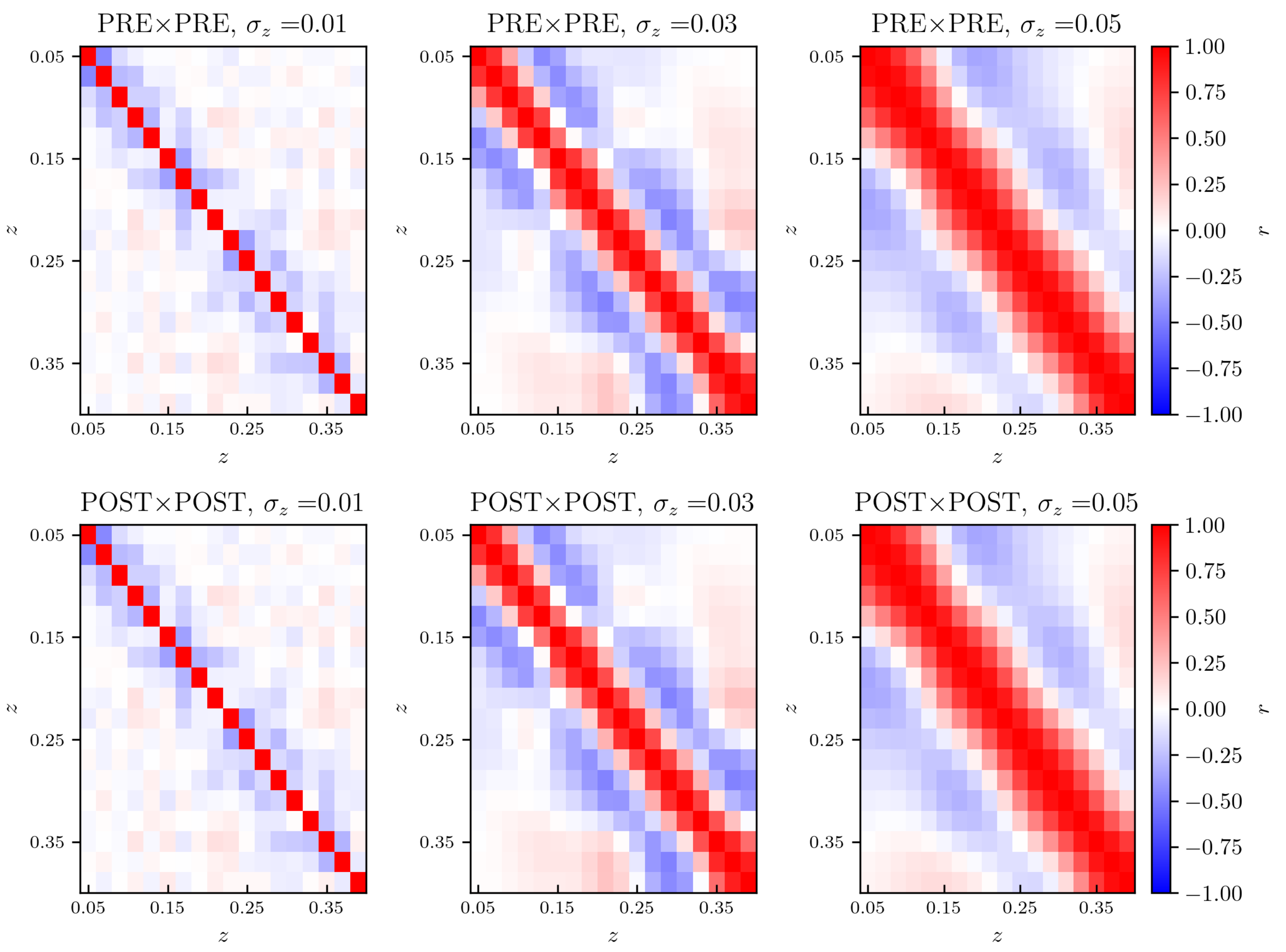
ADF covariance matrices, APM



ADF covariance matrices, RvM



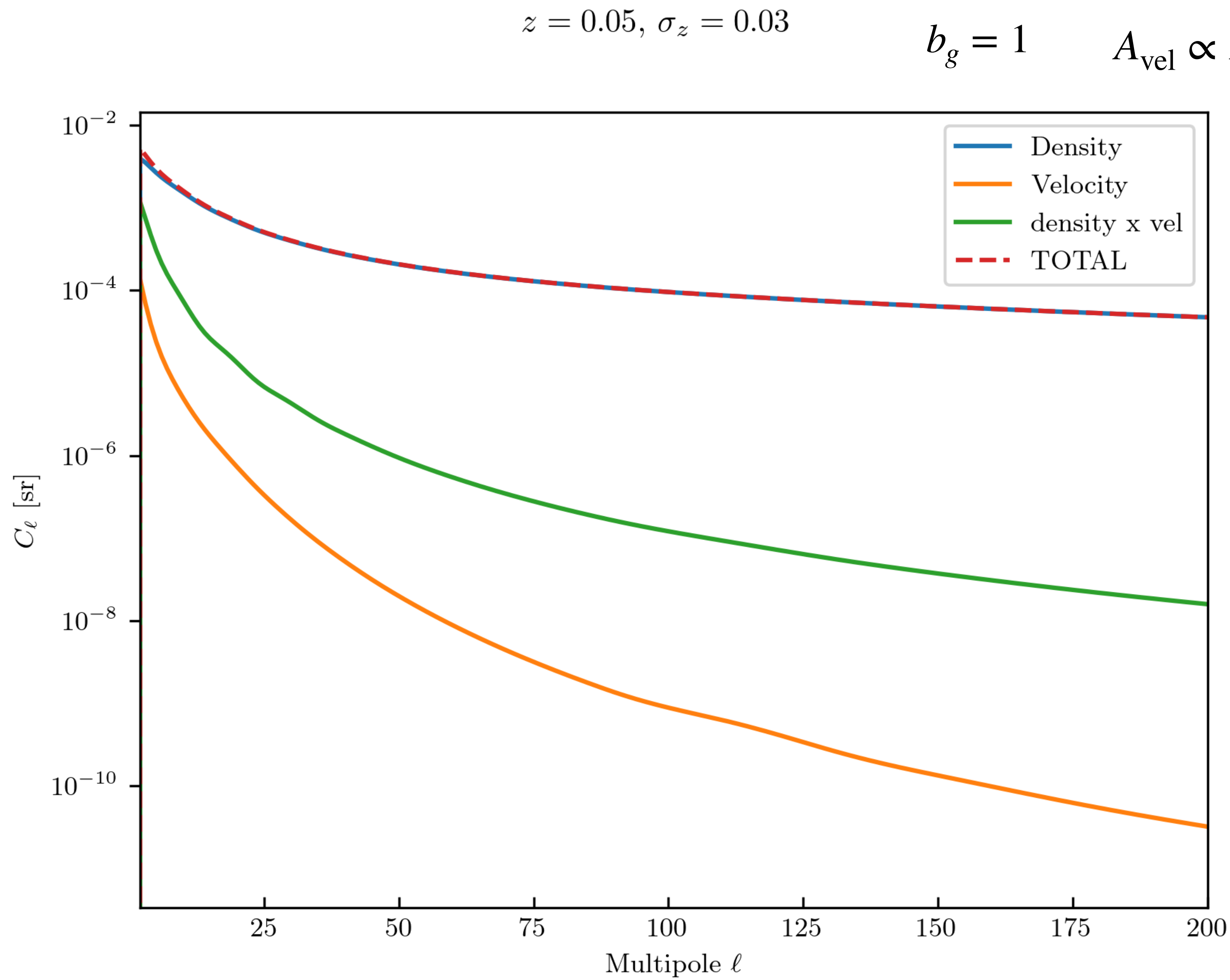
ARF covariance matrices, APM



For **both** ADF and ARF the observed angular power spectra break like this:

$$C_\ell^{\mathrm{obs}} = b_g^2(z) C_\ell^{\mathrm{den}} + 2 b_g(z)\, A_{\mathrm{vel}} C_\ell^{\mathrm{den,\,vel}} + A_{\mathrm{vel}}^2\, C_\ell^{\mathrm{vel}} + \text{shot noise}$$

$b_g = 1$ $\quad A_{\mathrm{vel}} \propto E(z) f(z) \sigma_8(z)$



Unlike the ADF, **the ARF are sensitive to errors in photometric redshifts:**

$$\delta z^{\rm photo}(\hat{n}) = \frac{1}{N}\int dz \frac{d\bar{N}}{dz}(1+\delta_g)\left(z_H + z_{\rm vel} + z_{\rm error} - \bar{z}\right)\exp\left[-(z_H + z_{\rm vel} + z_{\rm error} - z_{{\rm center}_{\rm j}})^2/(2\sigma_z^2)\right] \Rightarrow$$

$$\langle(\delta z^{\rm photo})^2(\hat{n})\rangle^2 \simeq \exp - [(\sigma_{\rm Err}/\sigma_z)^2]\,\langle\delta z^2(\hat{n})\rangle^2$$

We shall be measuring the following set of parameters:

$$\{\sigma_{{\rm photo}-z}, b_{i=1,{\rm nshell}}, A_{\rm vel}\}$$

… or …

$$\{\sigma_{{\rm photo}-z,{\rm i}=1,{\rm nshell}}, b_{i=1,{\rm nshell}}, A_{\rm vel}\}$$

For **both** ADF and ARF the observed angular power spectra break like this:

$$C_\ell^{\rm obs} = b_g^2(z)C_\ell^{\rm den} + 2b_g(z)\,A_{\rm vel}C_\ell^{\rm den,\,vel} + A_{\rm vel}^2\,C_\ell^{\rm vel} + \text{shot noise}$$

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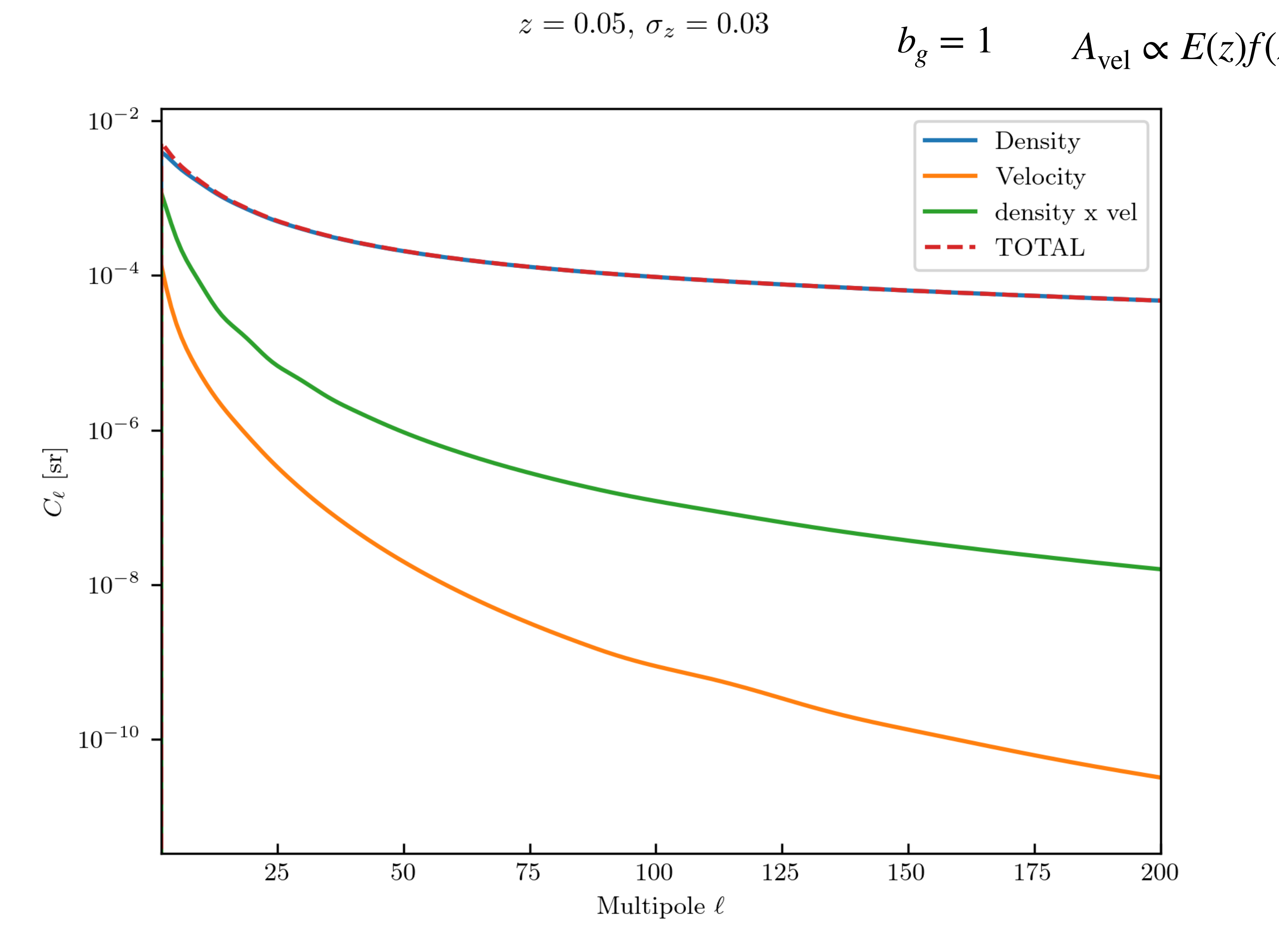

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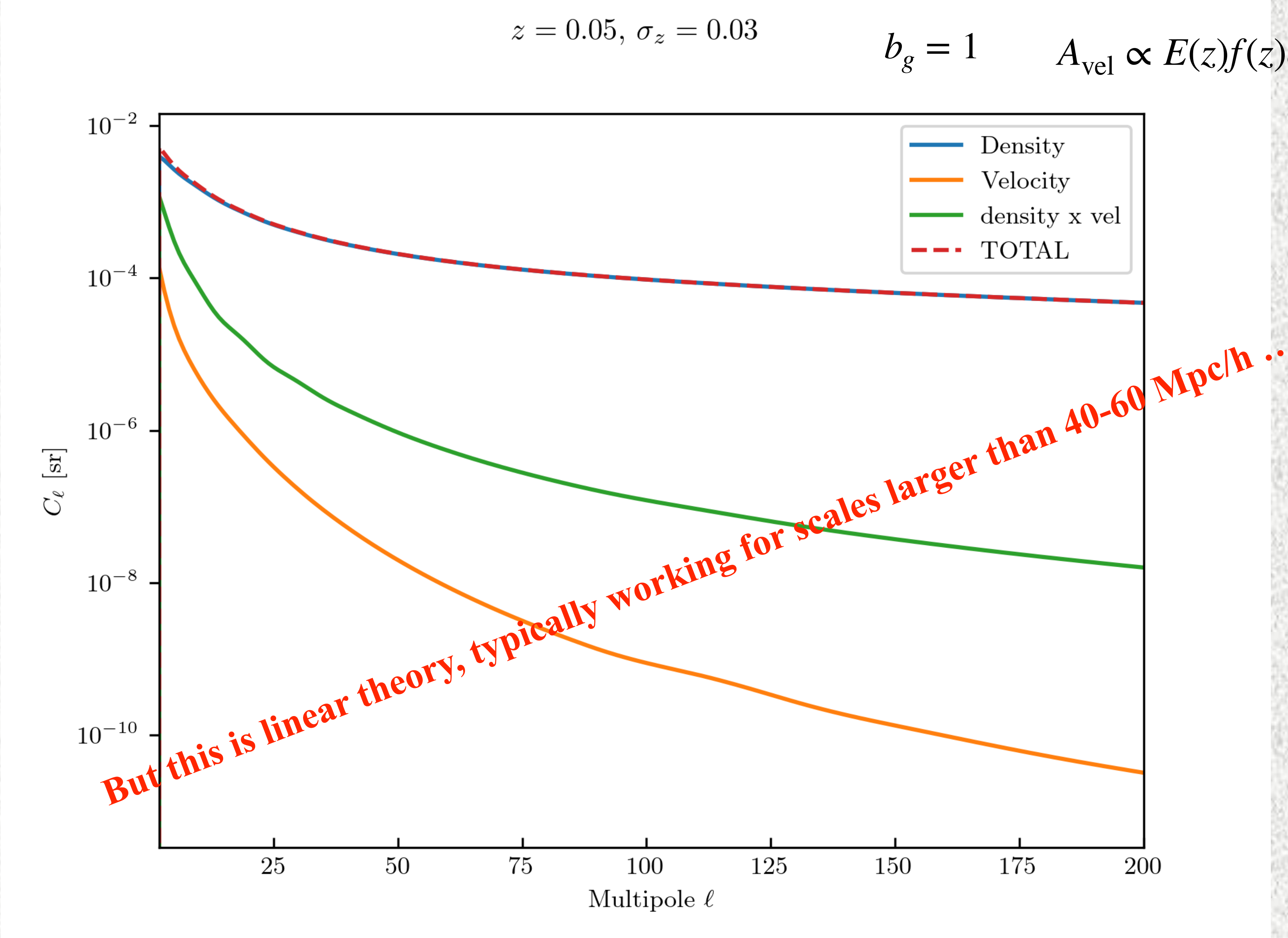

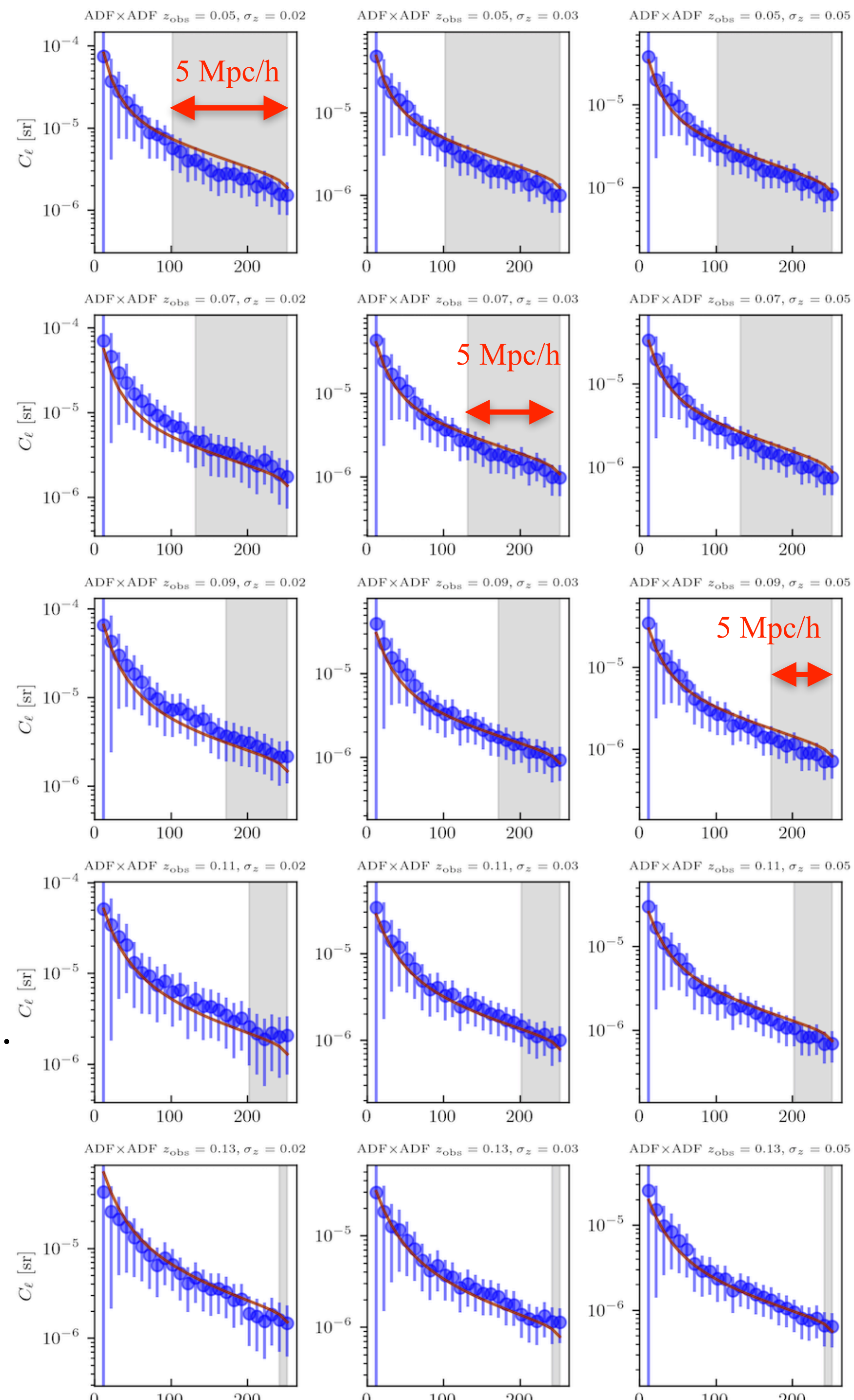

Real J-PLUS DR3
ADFs (RvM)

J-PLUS DR3 is probing
deeply in the non-linear regime …

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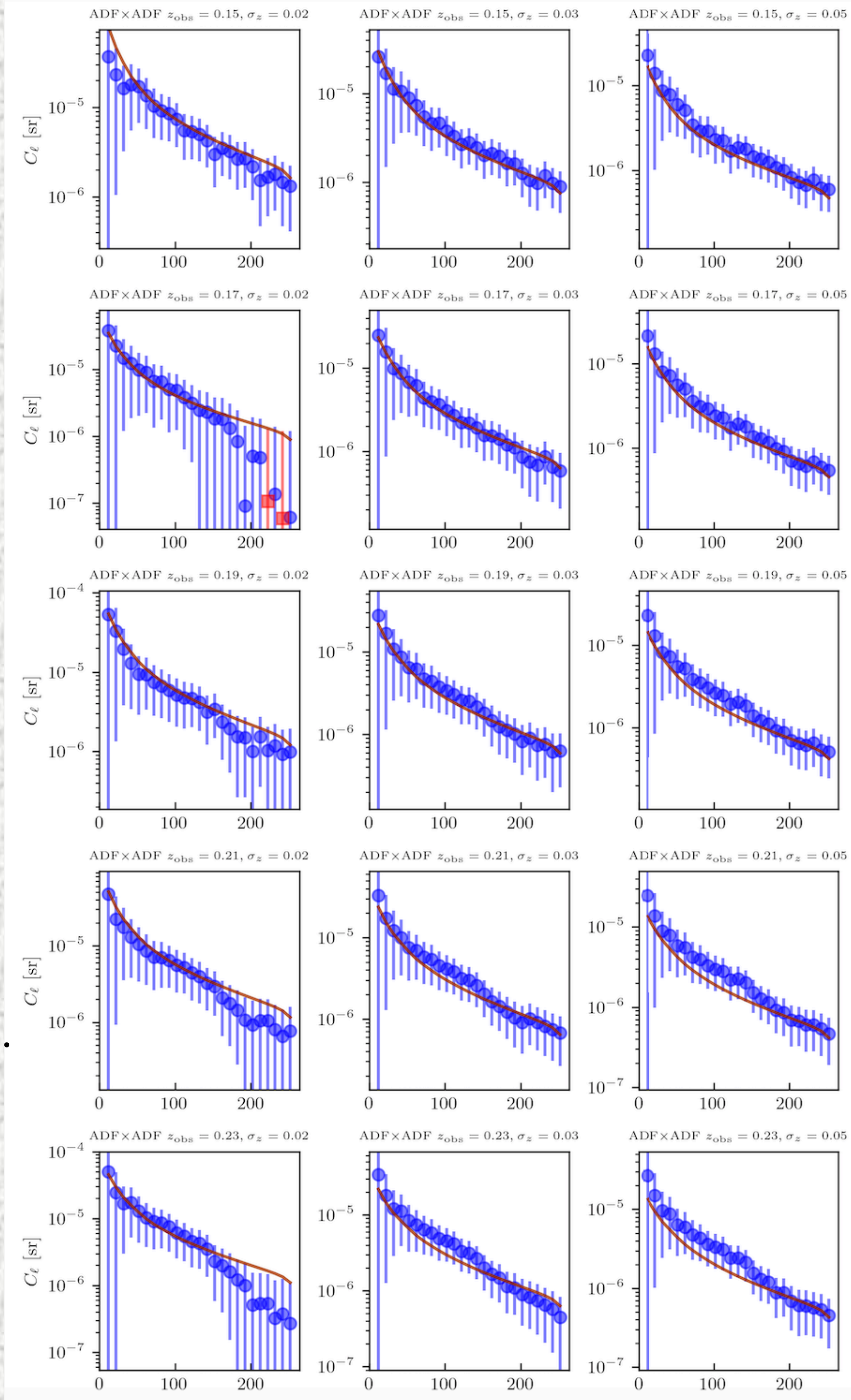
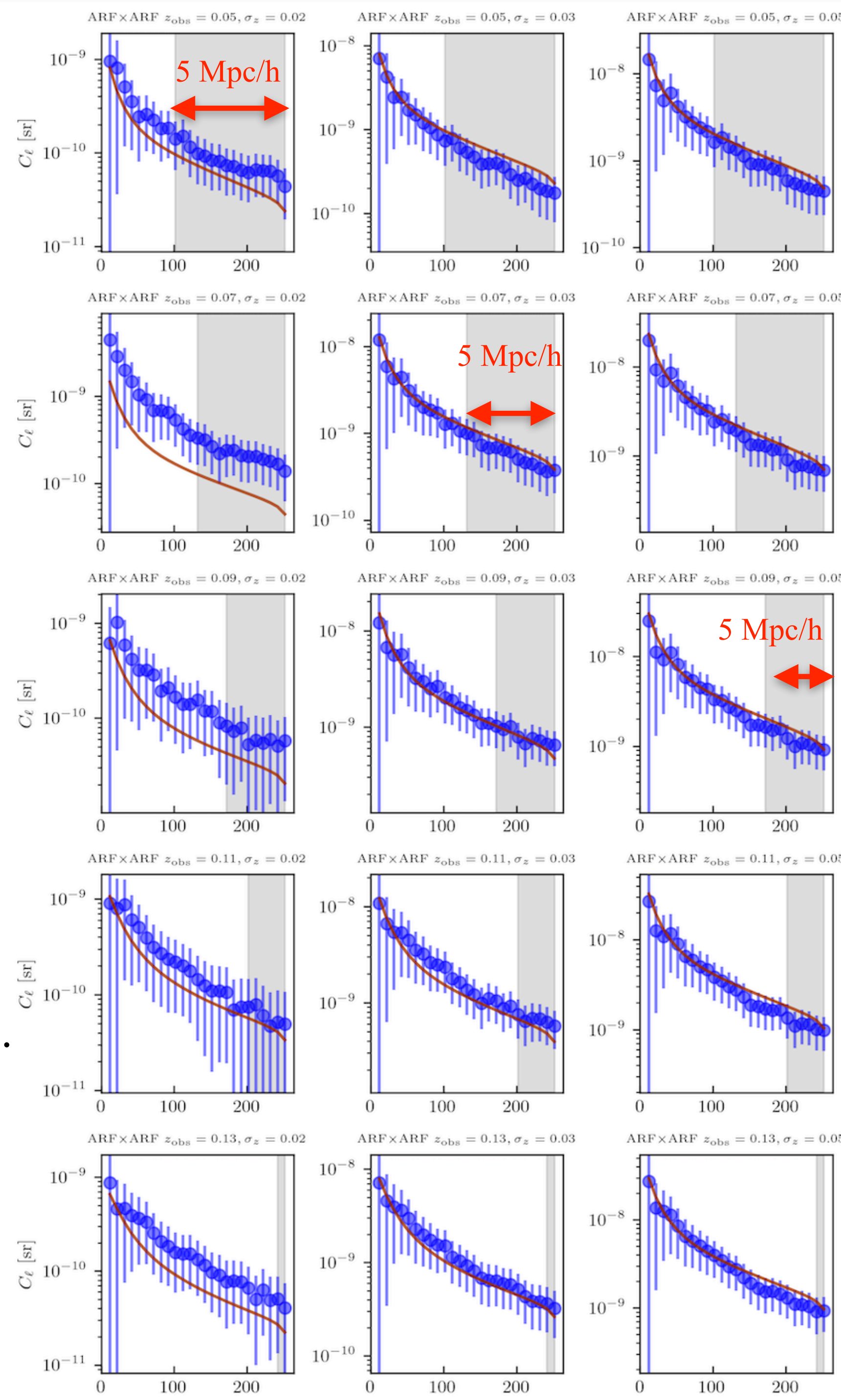


Real J-PLUS DR3
AR**Fs** (RvM)



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deeply in the non-linear regime …

Real J-PLUS DR3
ARFs (RvM)

J-PLUS DR3 is probing
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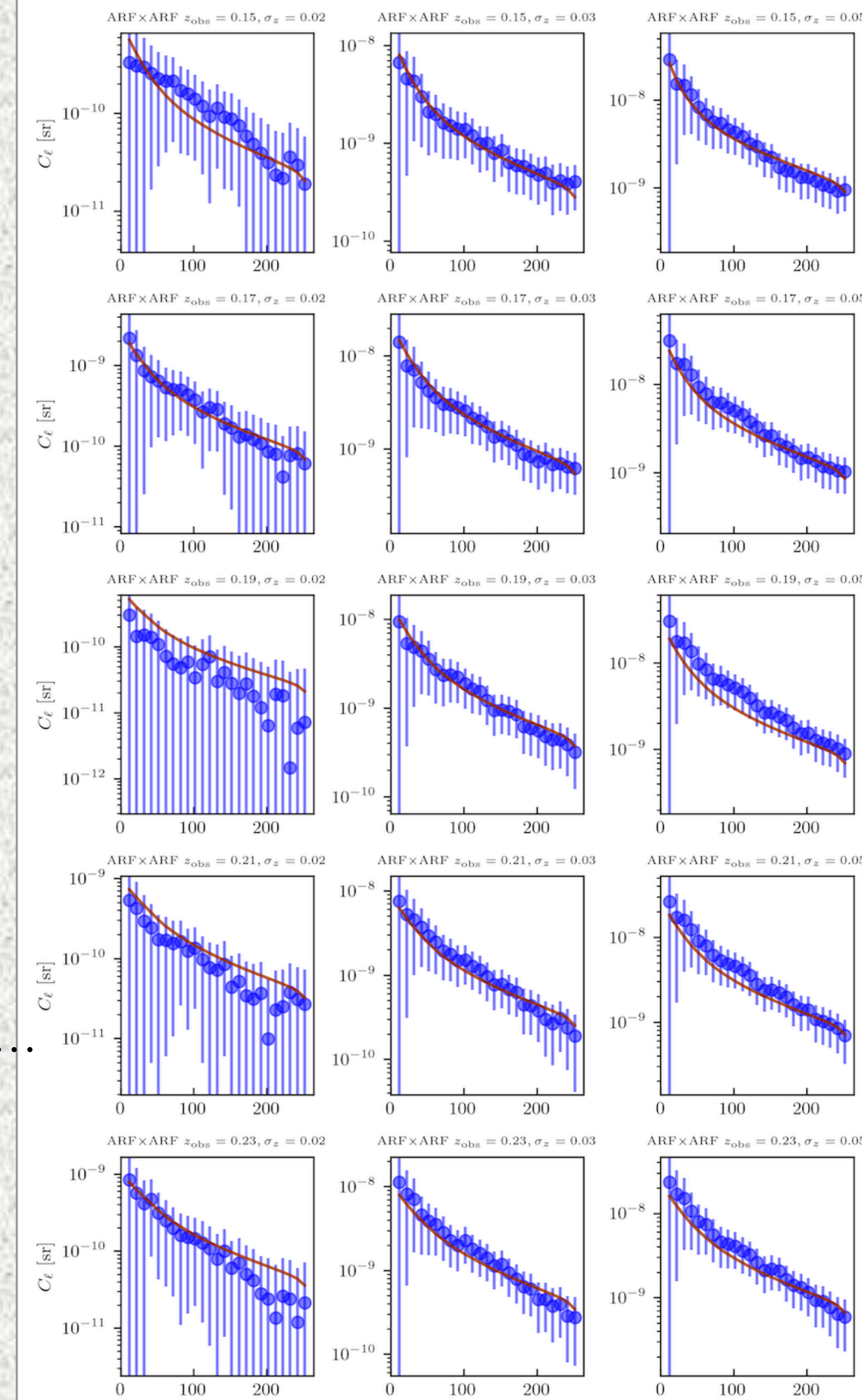
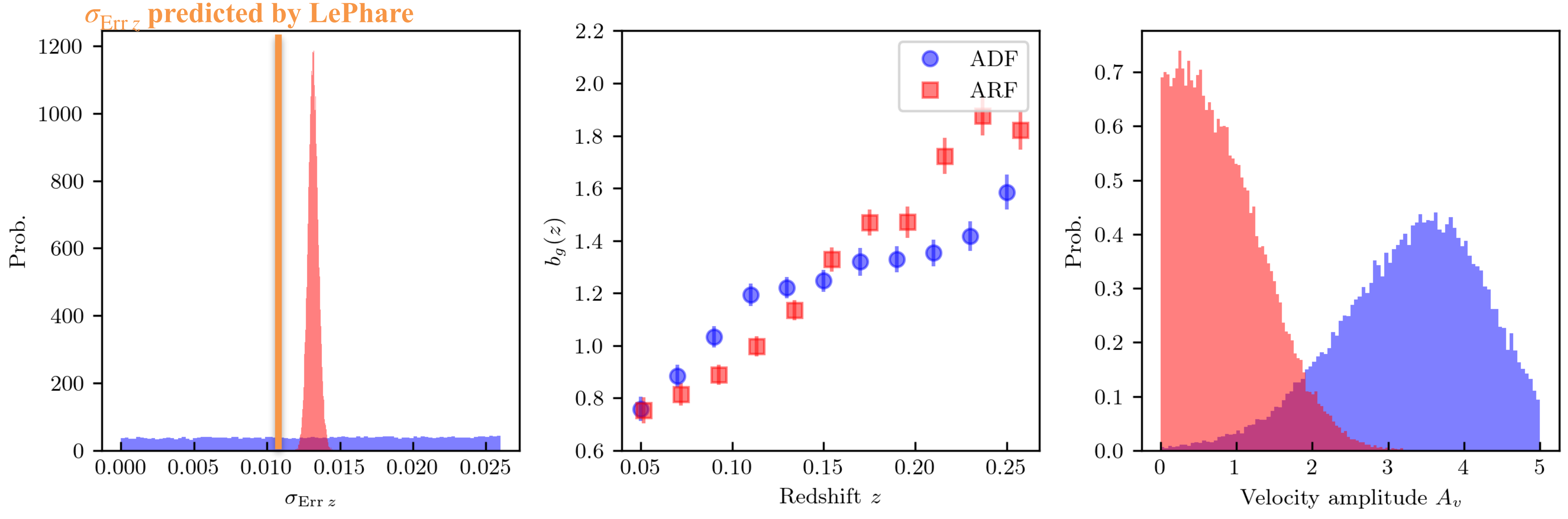


MCMC on the parameter set

$$\{\sigma_{\text{photo}-z}, b_{i=1,\text{nshell}}, A_{\text{vel}}\}$$

obtained upon a "simplified" covariance matrix



MCMC on the parameter set

$$\{\sigma_{\mathrm{photo}-z,\mathrm{i=1,nshell}}, b_{i=1,\mathrm{nshell}}, A_{\mathrm{vel}}\}$$

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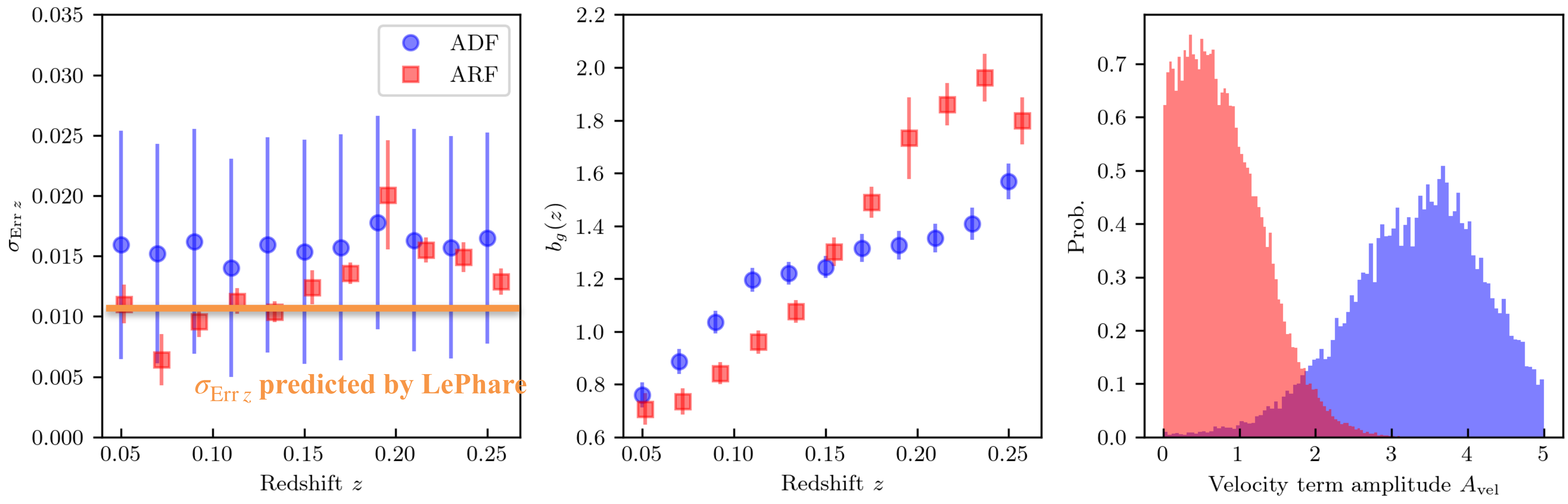
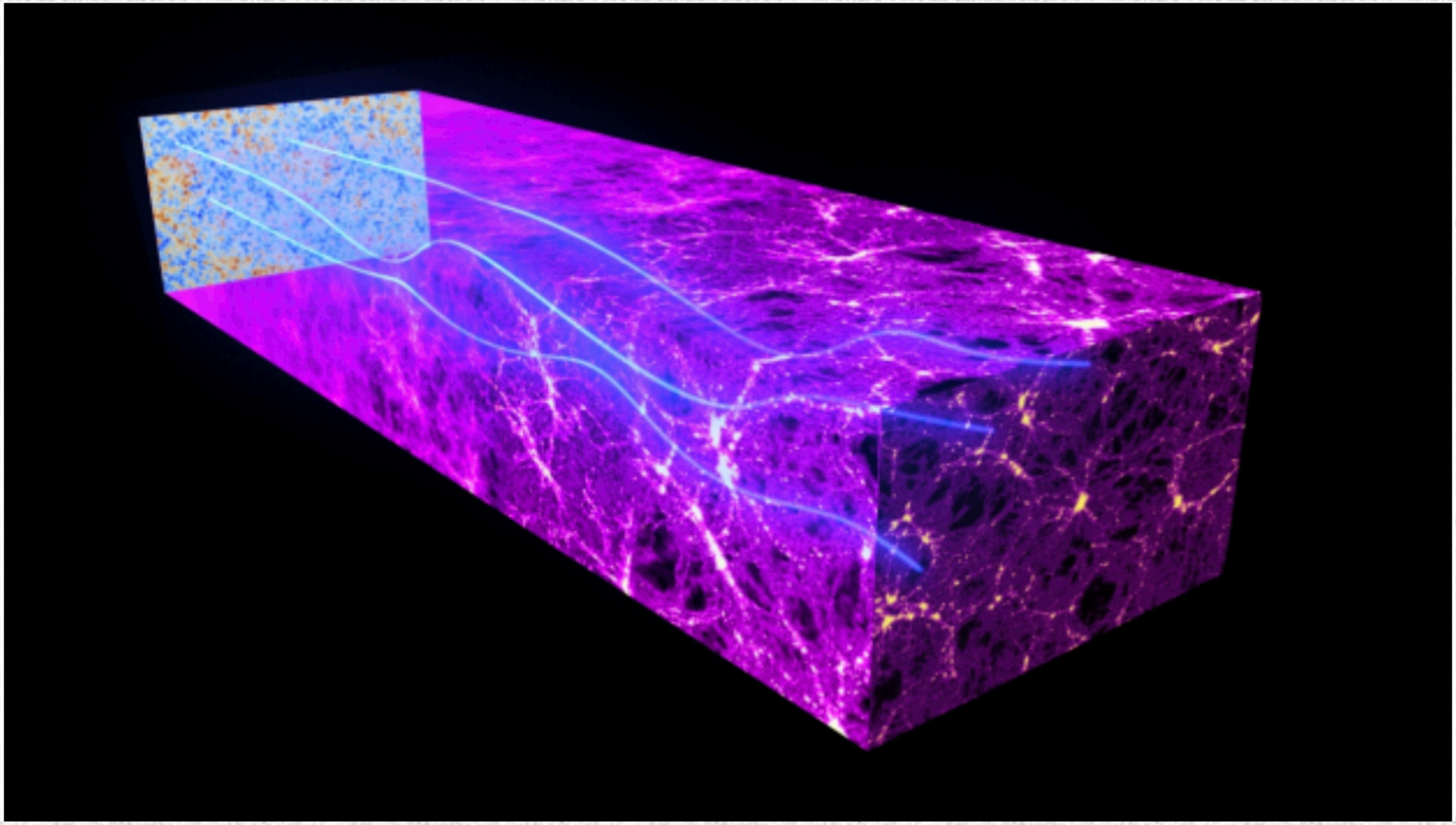
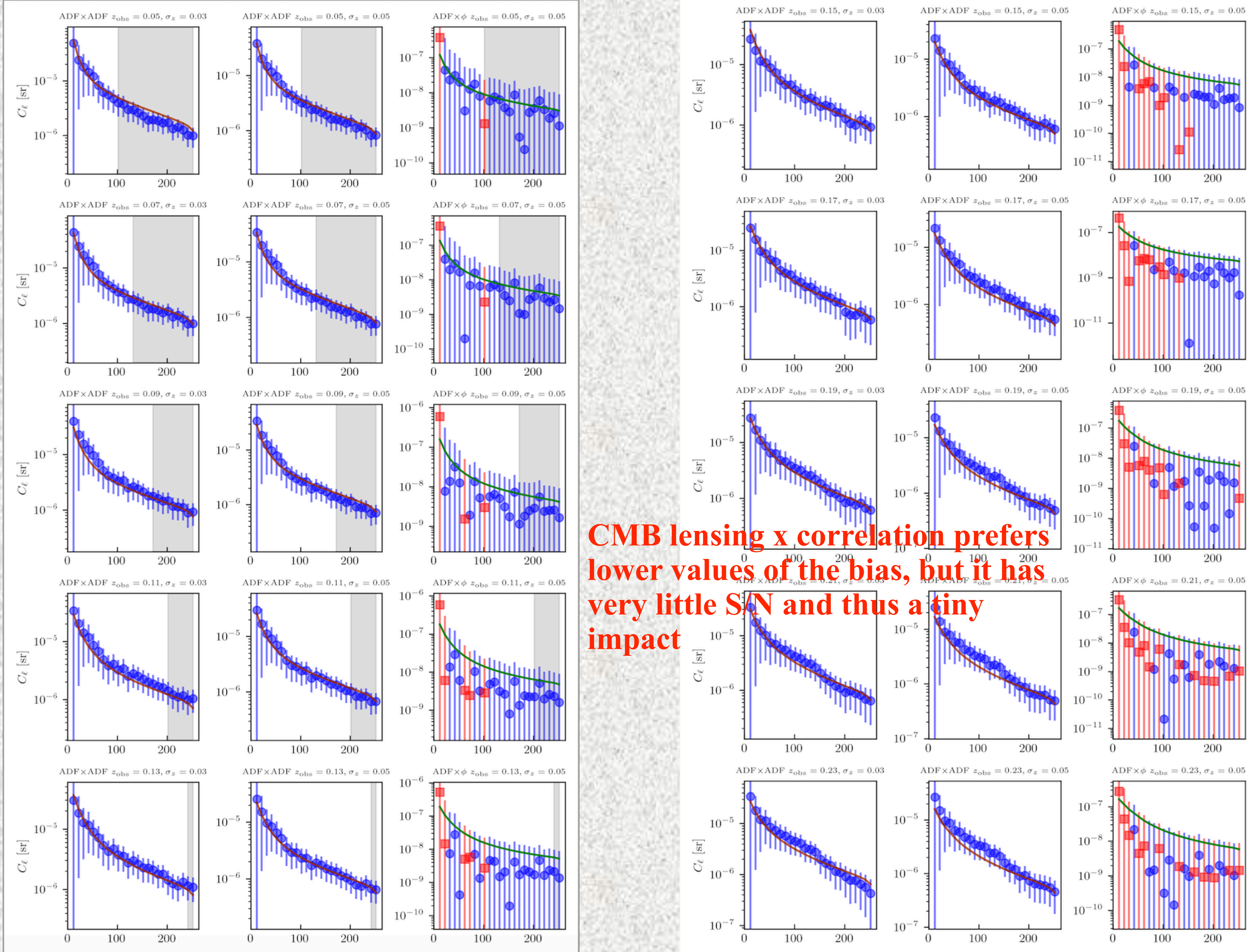


Could the CMB help out here?



We can cross-correlate J-PLUS DR3 maps with maps of lensing convergence, that are sensitive to the projected gravitational potential. The *z*-window function for this cross-correlation peaks typically at *z~2,* but it is wide and there may be some signal with J-PLUS DR3 …

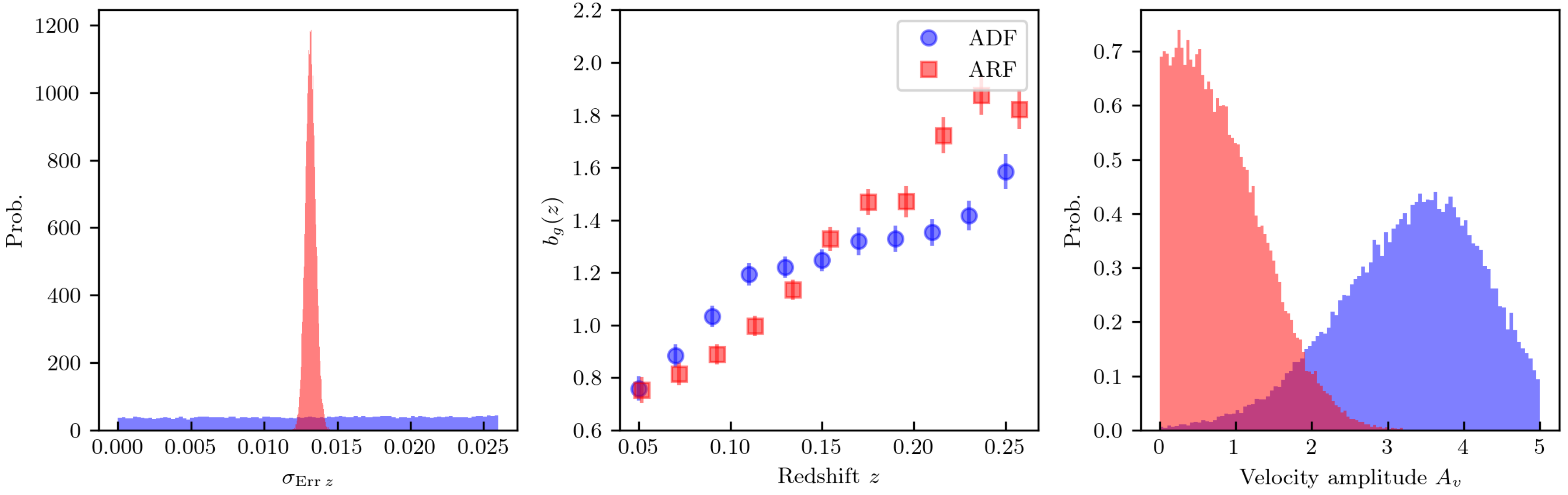


CMB lensing x correlation prefers lower values of the bias, but it has very little S/N and thus a tiny impact

MCMC on the parameter set

$$\{\sigma_{\text{photo}-z}, b_{i=1,\text{nshell}}, A_{\text{vel}}\}$$

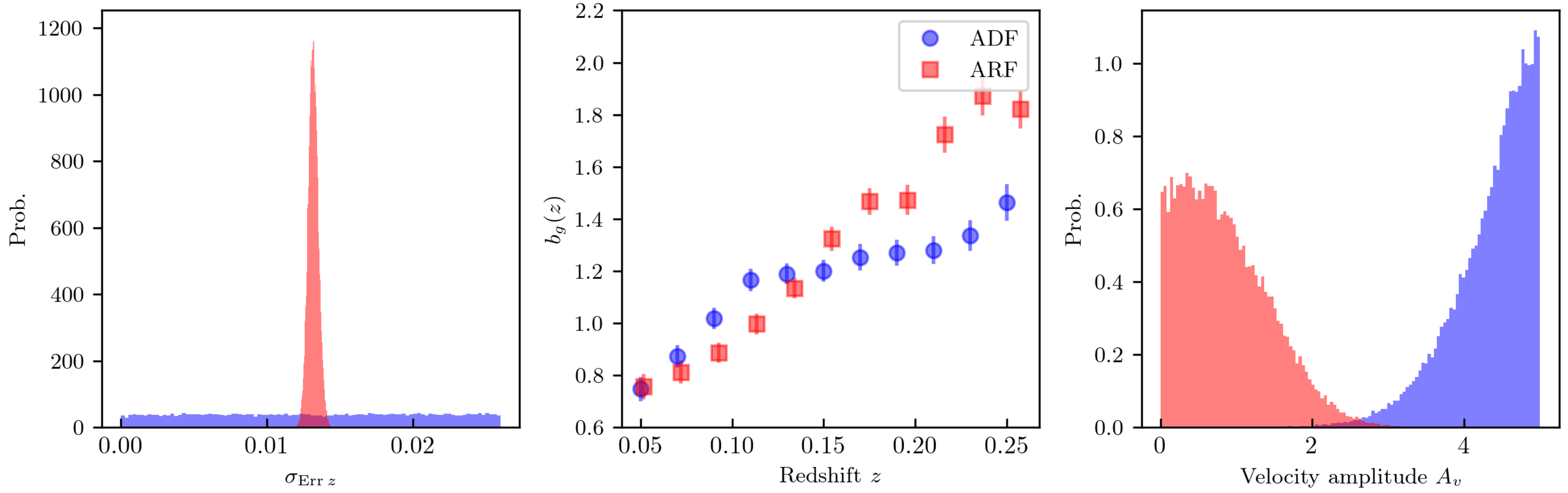
obtained upon a “simplified” covariance matrix



MCMC on the parameter set + CMB κ map

$$\{\sigma_{\text{photo}-z}, b_{i=1,\text{nshell}}, A_{\text{vel}}\}$$

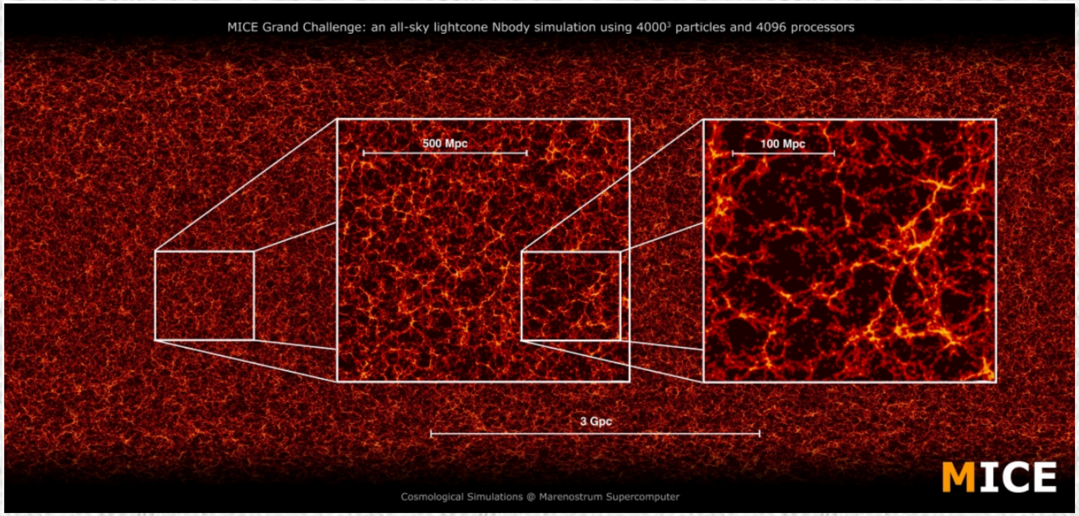
obtained upon a “simplified” covariance matrix



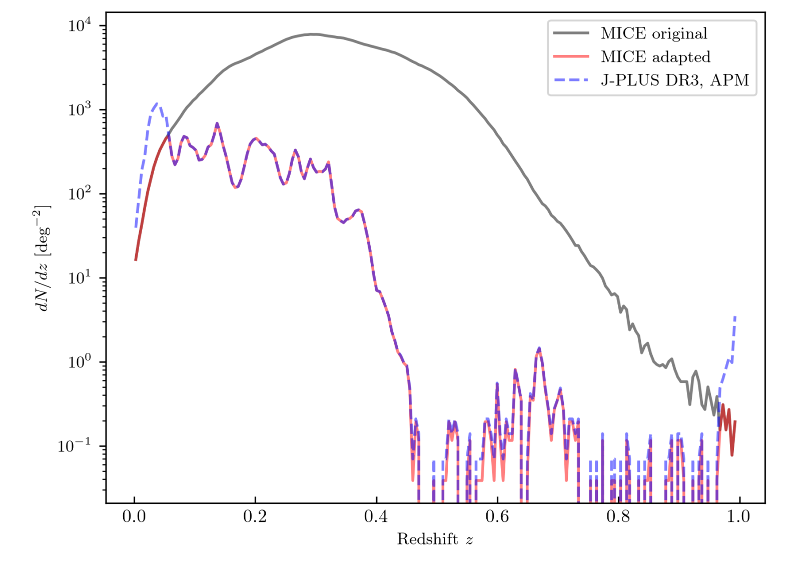
Do we see a similar trend in **mocks**?

Let's look at the **MICE** simulation:

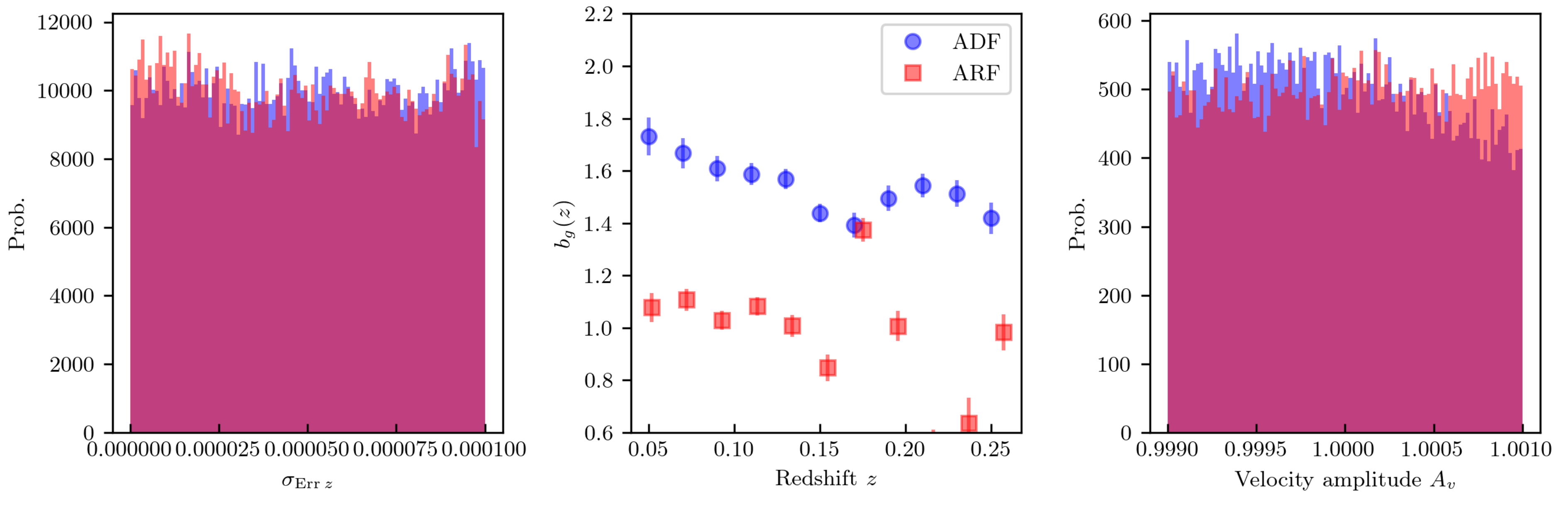
$\Omega_m = 0.25;\ \Omega_\Lambda = 0.75;\ \Omega_b = 0.044;\ n_S = 0.95;\ h = 0.7;\ w_0 = -1;\ w_a = 0$



We impose the same *r<21* cut, but we cannot apply the same odds cut since we lack J-PLUS photometry. We impose the same *dN/dz:*



The box is projected into an octant, 8,000 sq.deg



After fixing everything and neglecting photo-*z* errors, ADF typically provide **higher bias** values than ARF. The bias seems to decrease vs *z*, *contrary* to the expected behavior of the bias versus redshift, maybe hinting to probing scales that are *less* linear at higher *z*-s …

To be confirmed with the real J-PLUS mock !

Conclusions:

- A full **pipeline** for conducting **ADF & ARF 2D tomography** on any LSS survey (J-PLUS, J-PAS, eBOSS, DES, *Euclid* …) is in place and working

- When applied on J-PLUS DR3, we find that the **linear model provides good fit to both ADF/ARF** observations up to $z \sim 0.2$. Bias values of order unity, with a clear increasing trend in z, are found.

- The values of the bias are, however, clearly ***discrepant***. This points to **different sensitivities** of ADF and ARF to *non-linear* effects, which itself is a good test for spotting non-linear contamination. This seems to be confirmed when looking at the MICE mock.

- J-PLUS DR3 is at best **mildly correlated to *Planck*'s lensing** convergence map, which points to lower values of the bias than those inferred by ADF, pointing again to non-linear contribution.

- A **deeper** analysis of the **J-PLUS mock** (Izquierdo-Villalba et al. 2019) will be conducted before the submission of this work for publication (together with the systematics pipeline one — hopefully before the end of this 2023 year — *BTW, A&A or MNRAS?*