Summary of χpod / Chameleon EQ08 Analysis

Andy Pickering

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Contents

1 Overview

- This document is an attempt to provide an overview/summary of some analysis i've done with the EQ08 data. The motivation/goal for all this work is to show if /how well the CTD-χpod method works for estimating χ,ϵ, K_T, etc from fast temperature (thermistor) profiles. The idea is to deploy χpods on regular CTD casts on WOCE/CLIVAR cruises etc. to making mixing measurements.

- Before dealing with all the issues with the CTD deployments (depth loops, entrained water, rosette-induced turbulence etc.), I wanted to verify that the method itself worked w/out these complications.

- The Chameleon microstructure profiler has both thermistor and shear probes, so this seemed like an ideal way to test the method. I would apply the χpod method to the chameleon thermistor data only (χ_χ, ϵ_χ), and compare to the 'true' results computed using the shear probes (χ,ϵ).

2 Data and Processing

- Data are from Chameleon profiles near the equator during the 'EQ08' experiment.
- χpod method is applied to thermistor data from Chameleon profiles in : `ComputeChi_Chameleon_Eq08.m`
- The noise floor of Chamleon ϵ was determined to be $log_{10}[\epsilon] = -8.5$. Values below this threshold were discarded. χpod values below this threshold were also discarded, in order to make a valid comparison. An upper limit of $log_{10}[\epsilon] = -5$ was also applied.
- I re-processed the Chameleon data (`run_eq08_AP.m`) using a fmax of 15hz for the χ calculations, based on looking at spectra and where they rolled off.
- Data including surface convection was identified and excluded in the analysis. The mixed layer depth was identified using a criteria of $\sigma -_{surface} = 0.04$. This depth is shown in figures 1 and 2. These depths were found w/ `Identify_ML_eq08.m`
- The figures in this document are made w/ `Make_Overview_Plots_eq08.m`.

3 Results

3.1 Overview

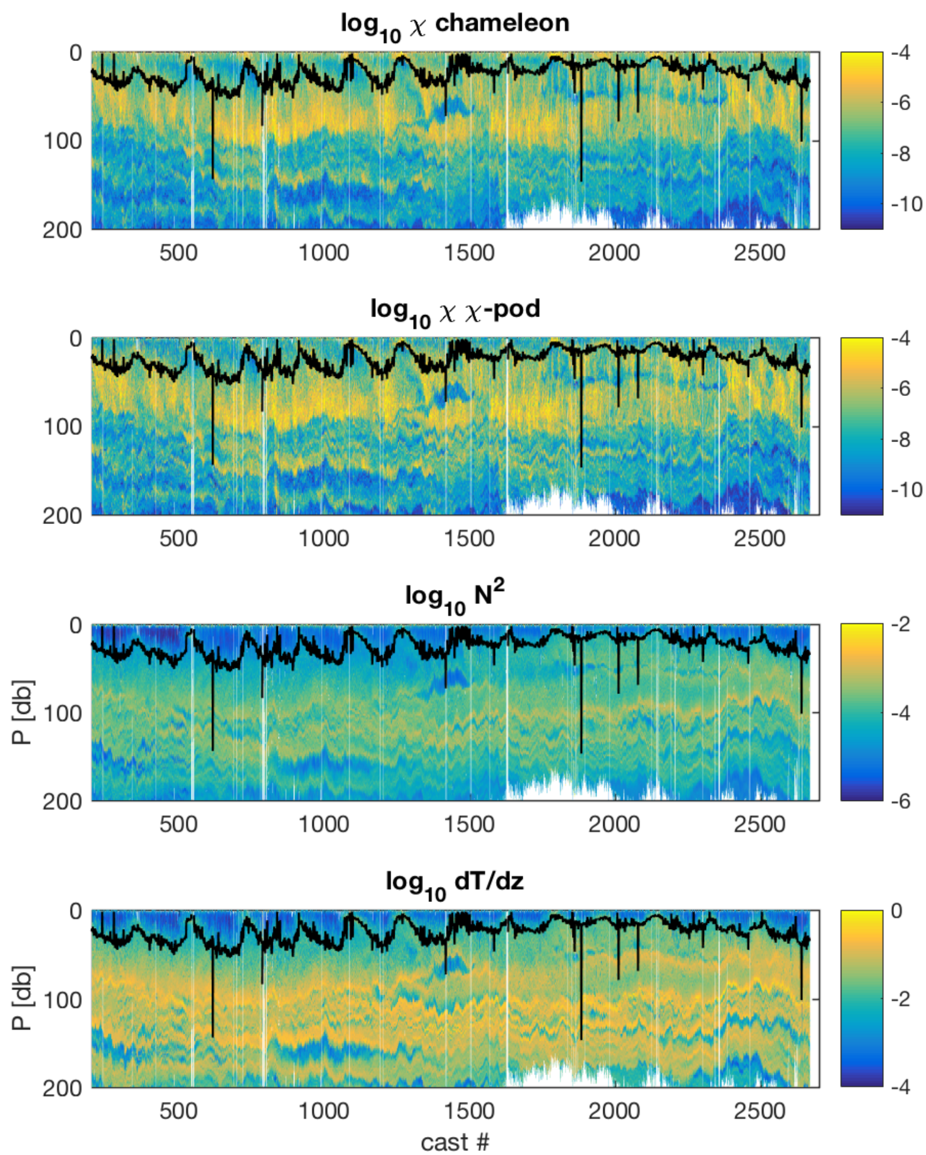


Figure 1: Comparison of χ from chameleon method and chi-pod method, for eq08 chameleon profiles. Date from each profile were averaged in 2m bins. Black line shows shows convective regions excluded in further analysis.

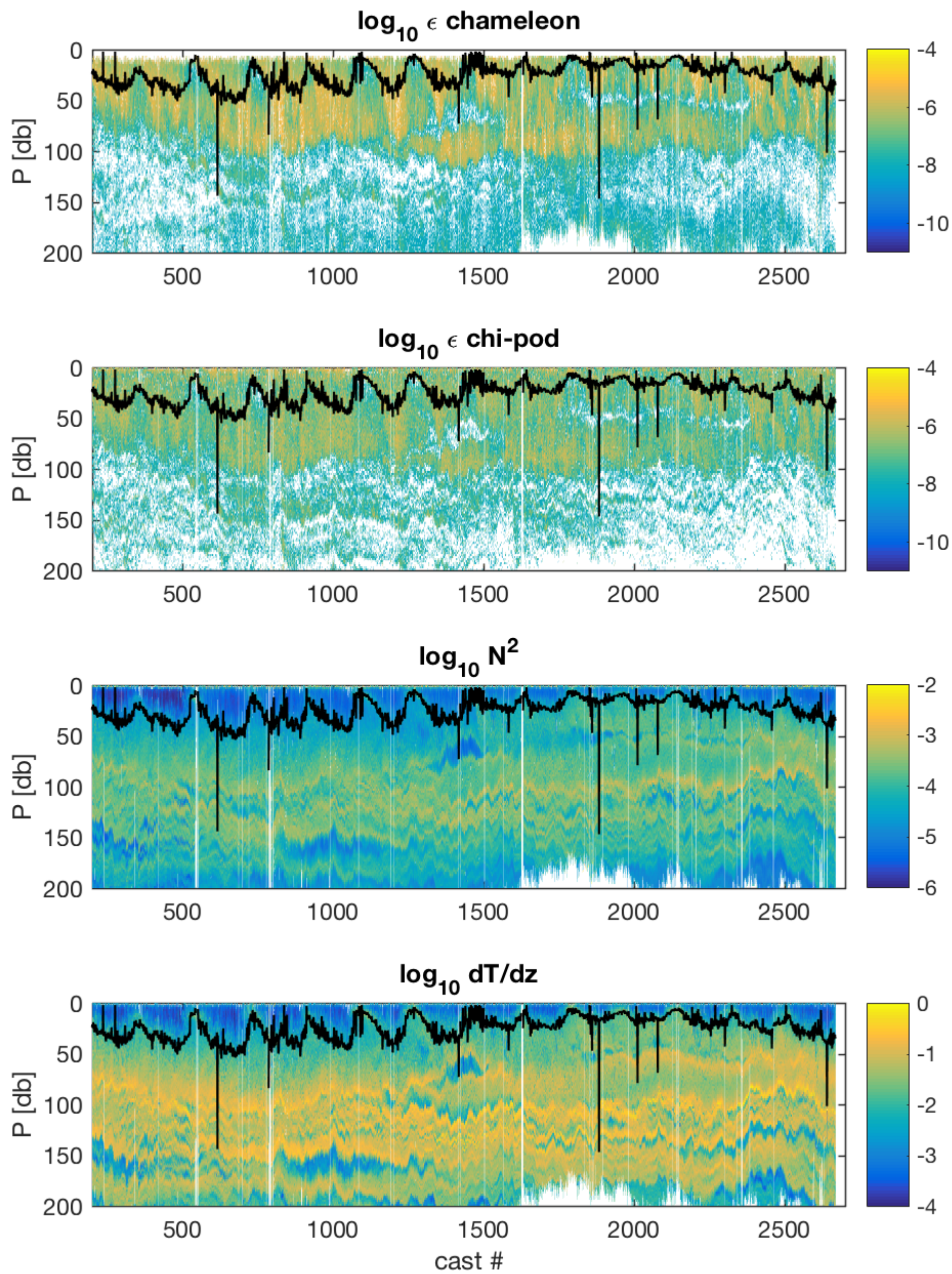


Figure 2: Comparison of ϵ from chameleon method and chi-pod method, for eq08 chameleon profiles. Each profile was averaged in 2m bins. Values of ϵ_χ and ϵ below chameleon noise floor ($log_{10}[\epsilon] = -8.5$) have been nan'd out. Black line shows shows convective regions excluded in further analysis.

3.2 ϵ_χ vs ϵ

I first compared ϵ_χ vs ϵ_χ vs ϵ for the Chameleon data, where $\epsilon_\chi = N^2\chi/2/\gamma/T_z^2$, using $\gamma = 0.2$. ϵ_χ underestimates ϵ, showing that that relationship (assumed in χpod processing does not hold here.

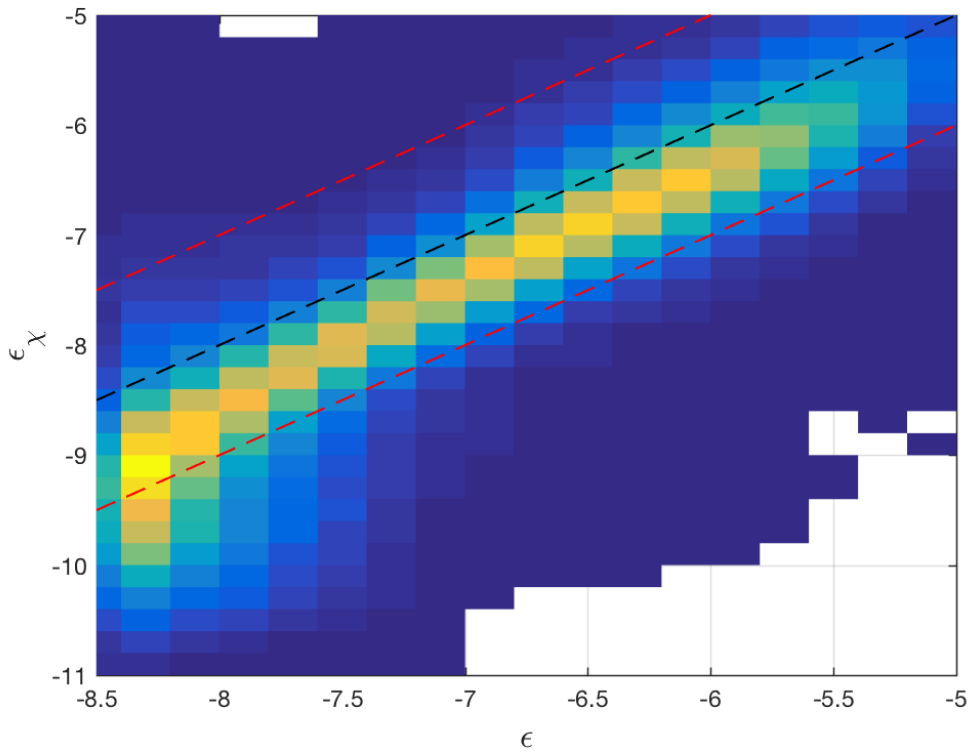
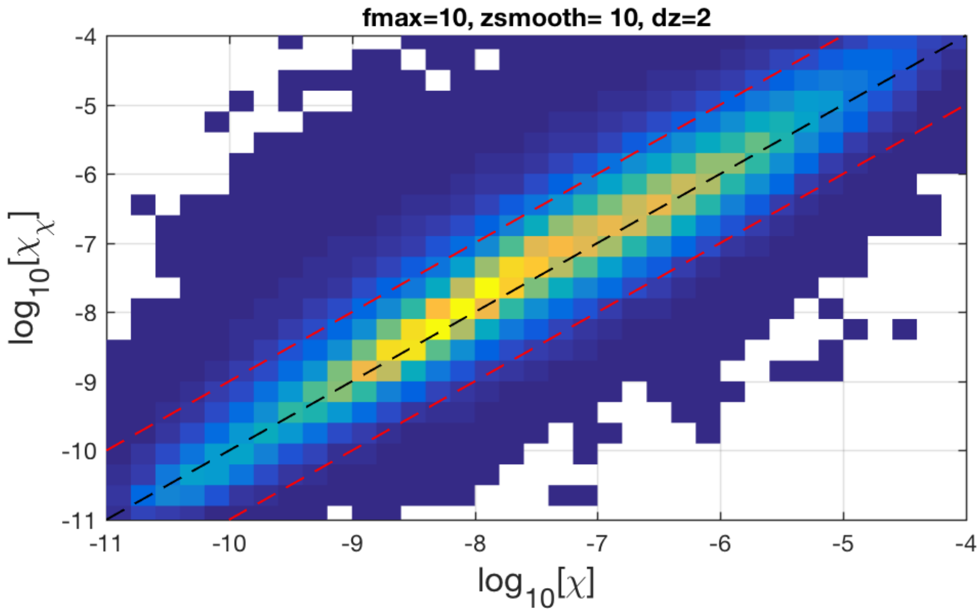


Figure 3: 2D histogram of ϵ_χ vs ϵ for Chameleon data.

3.3 Comparing individual estimates of ϵ

- The χpod method tends to slightly over-estimate χ, and underestimate ϵ (Figures 4,5). ϵ seems to be more under-estimated at higher values of ϵ.
- The bias in tends to be larger (more negative) at shallower depths (Figure 6).



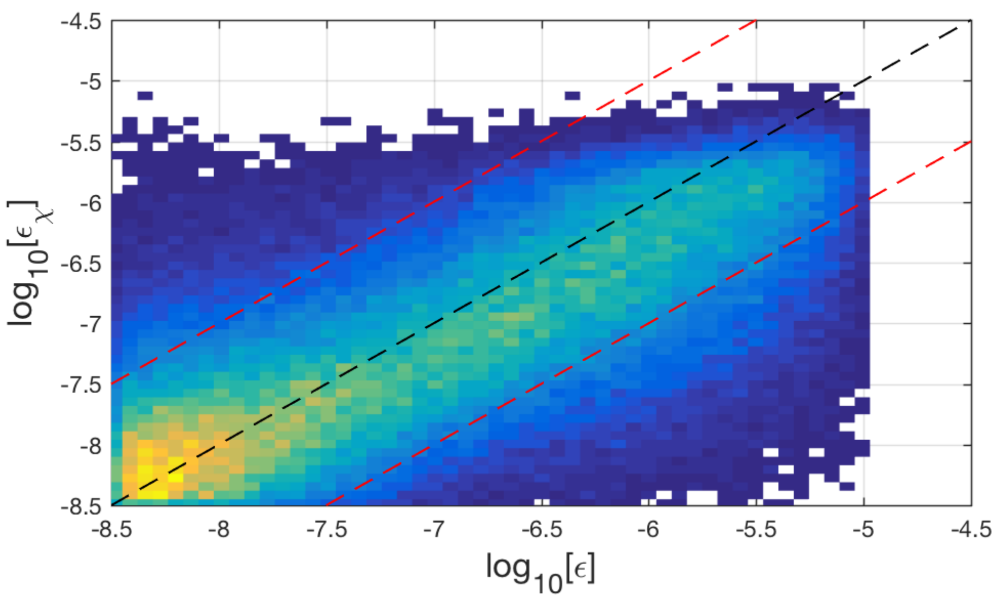


Figure 4: Comparison of χ (top) and ϵ (lower) from chameleon method and chi-pod method, for eq08 chameleon profiles. Each profile was averaged in 2m bins. Values of below chameleon noise floor ($log_{10}[\epsilon] = -8.5$) have been nan'd out. Black line is 1:1, red lines are $+/-$ order of magnitude.

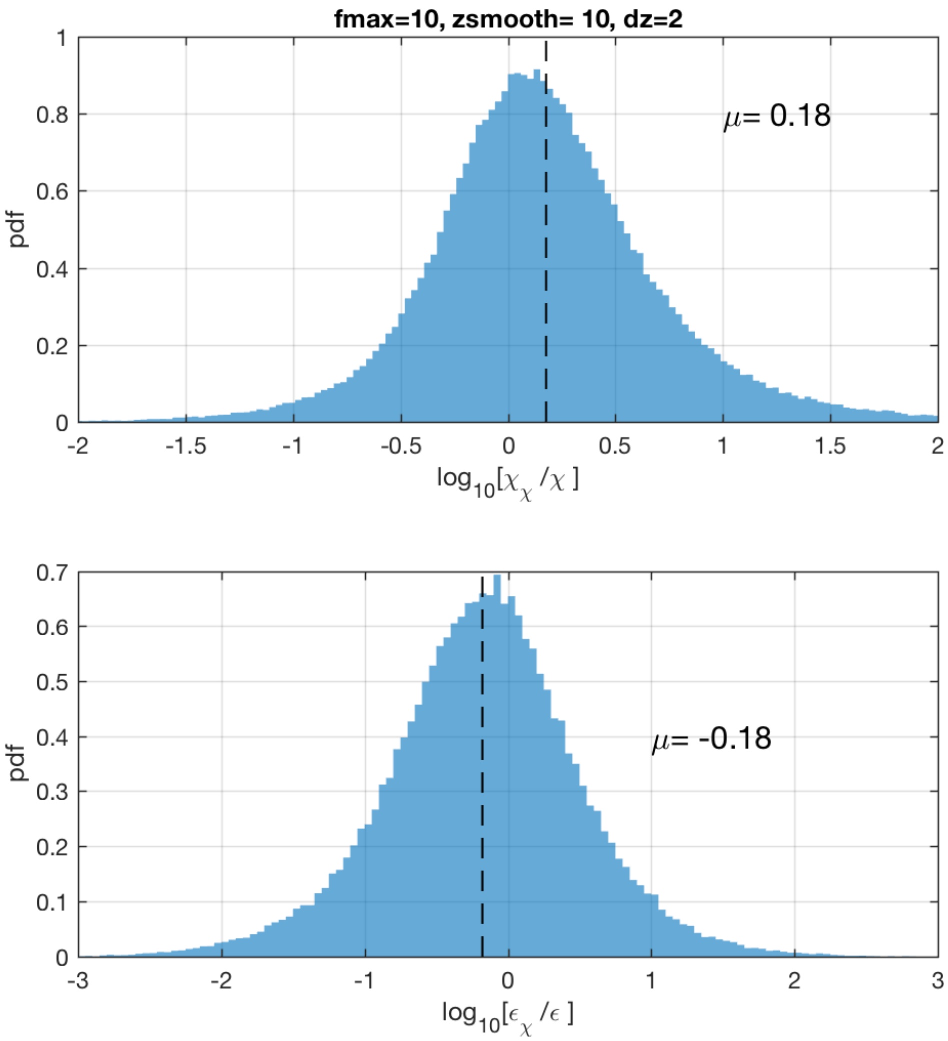


Figure 5: eq08: Histogram of the ratio of ϵ estimates from χpod method to the chameleon values. Estimates for each profile were averaged in 10m depth bins. Vertical line shows mean of $log_{10}[\epsilon_\chi/\epsilon]$.

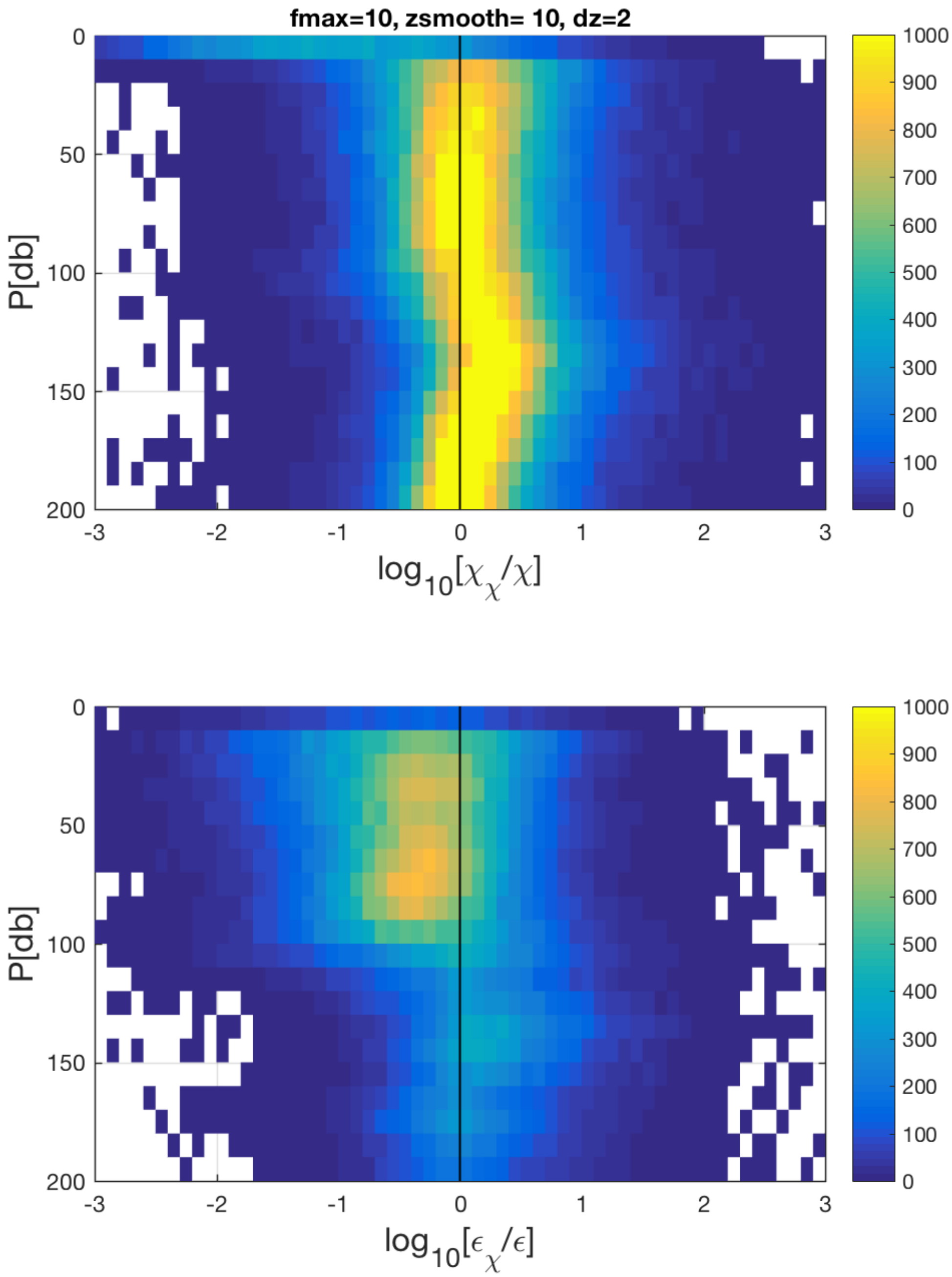


Figure 6: 2D histograms of ratios χ_χ/χ and ϵ_χ/ϵ ratios vs depth.

3.4 Dependence of bias on actual ϵ

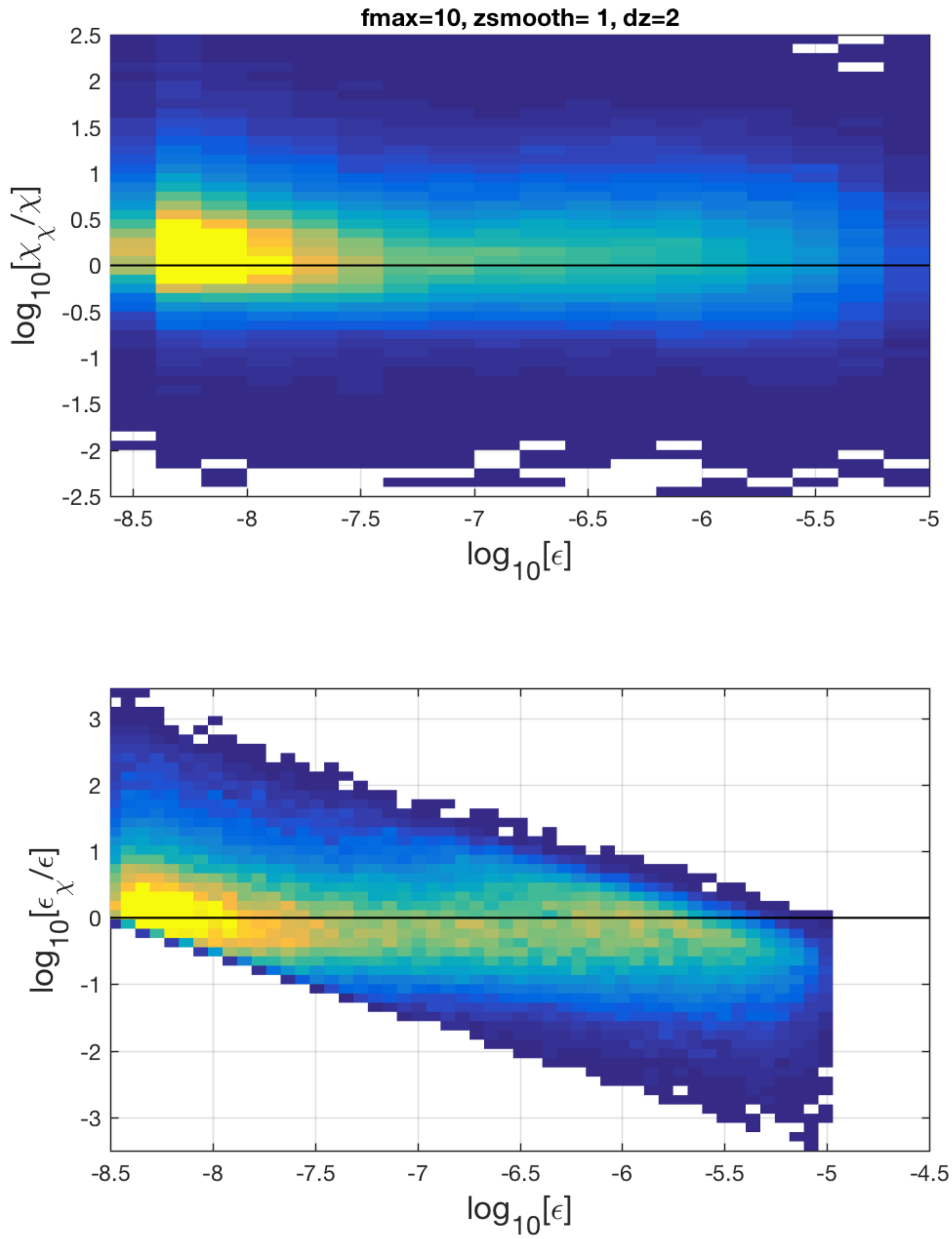


Figure 7: 2D histograms of ratios χ_χ/χ and ϵ_χ/ϵ ratios vs ϵ.

3.5 Normalized eps vs chi plots

Assuming that

$$\gamma = \frac{N^2\chi}{2\epsilon < T_z >^2} \tag{1}$$

, plotting $[\chi/t_z^2]$ vs $[\epsilon/N\hat{2}]$ should follow a straight line with slope equal to 2γ. The Chameleon data from EQ08 tend to fall near $\gamma = 0.1$ or slightly lower (Figure 8).

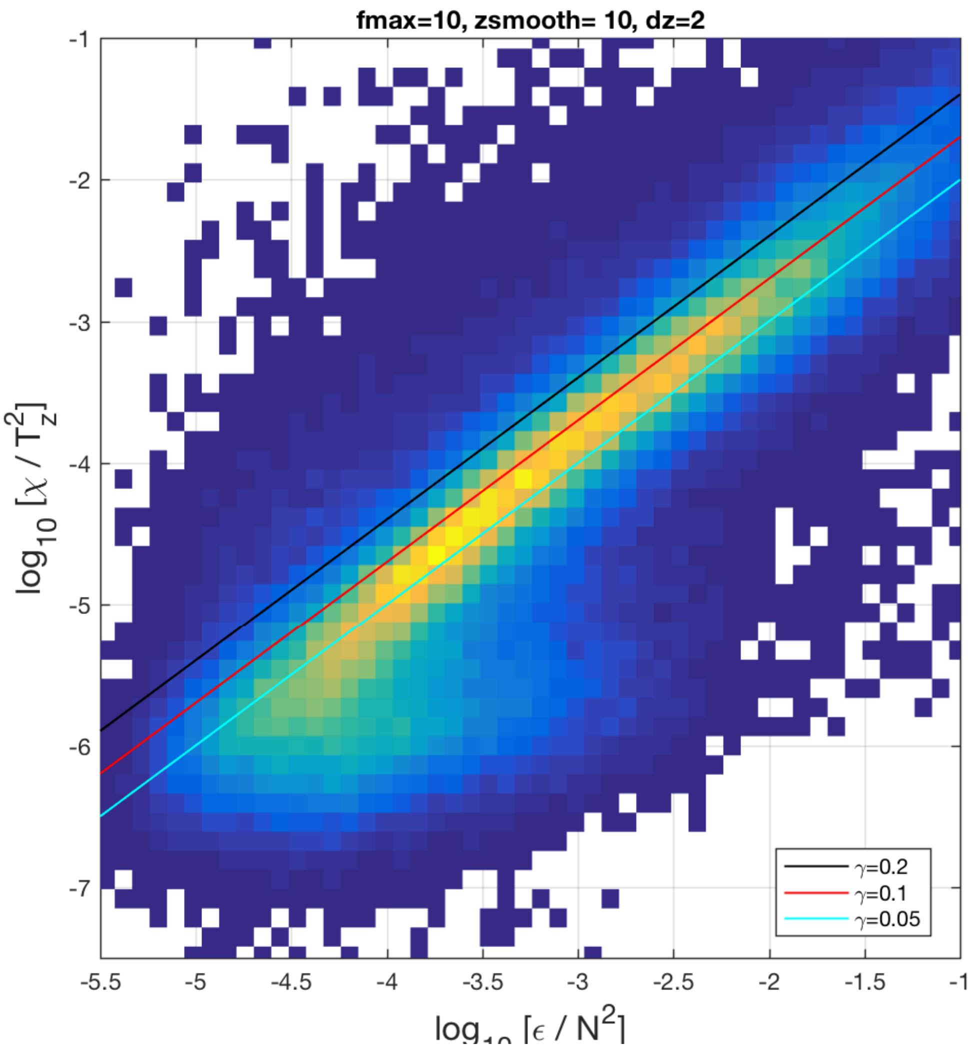


Figure 8: eq08: 10m binned chameleon $\epsilon/N\hat{2}$ vs χ/t_z^2. Lines show different values of γ. Values of ϵ below noise floor ($log_{10}\epsilon < -8.5$) are discarded also.

3.6 Averaging multiple profiles

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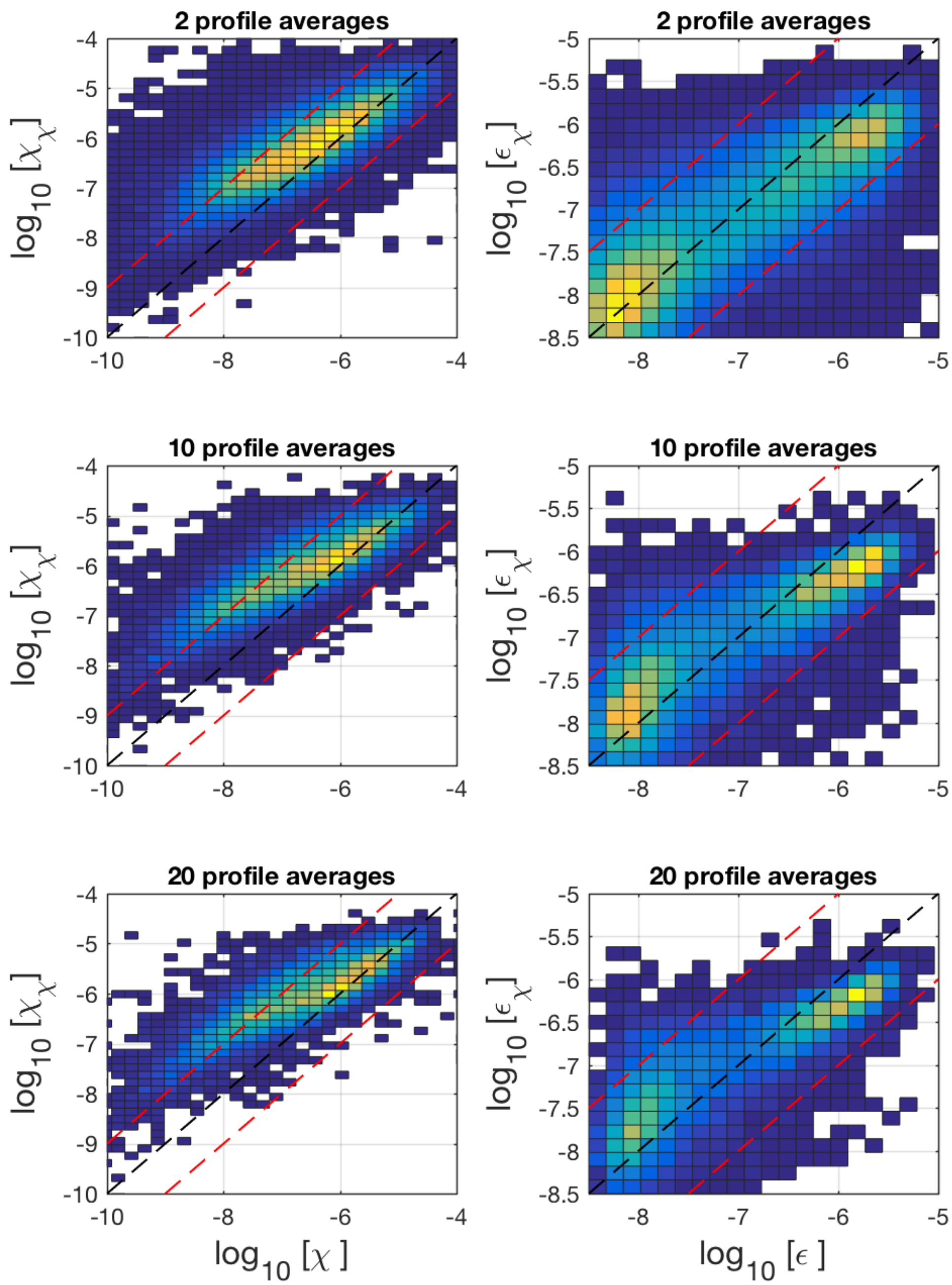

Figure 9: 2D Histograms of χ_{chi} vs χ (left) and ϵ_χ vs ϵ (right) for different numbers of profiles averaged.

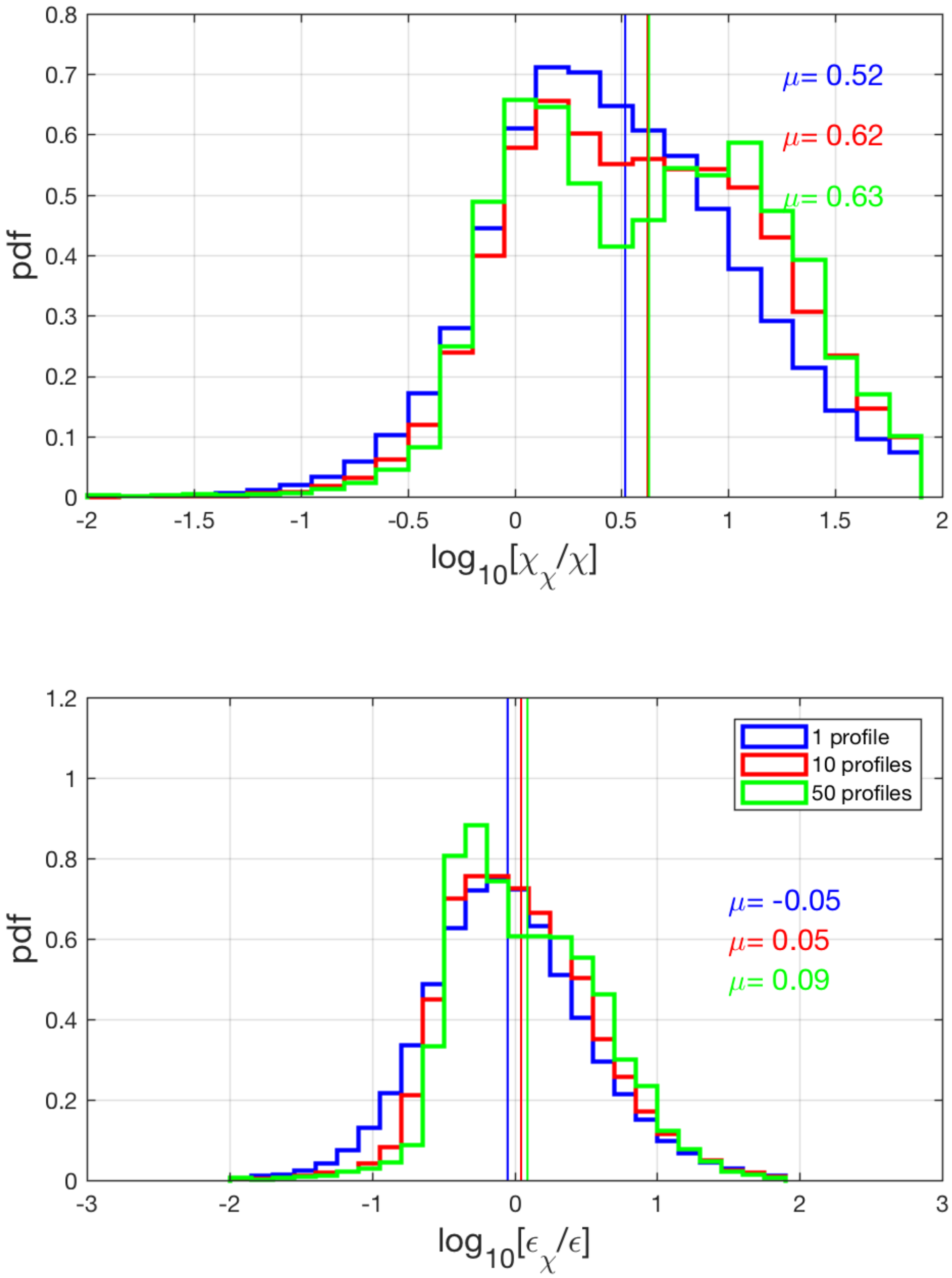

Figure 10: (log10) Ratio of ϵ_χ/ϵ for different numbers of profiles averaged. Consecutive chunks of N profiles were averaged, and then (normalized) histogram of the ratios was plotted. Vertical lines and numbers to right are mean of $log_{10}[\epsilon_\chi/\epsilon]$ for each distribution.

3.7 Averaging over different-sized depth bins

I also looked at the effects of averaging each profile in different sized depth bins instead of averaging profiles.

- The bias in ϵ is decreased with averaging over larger depth intervals, although the bias in χ increases slightly (Figure 12).

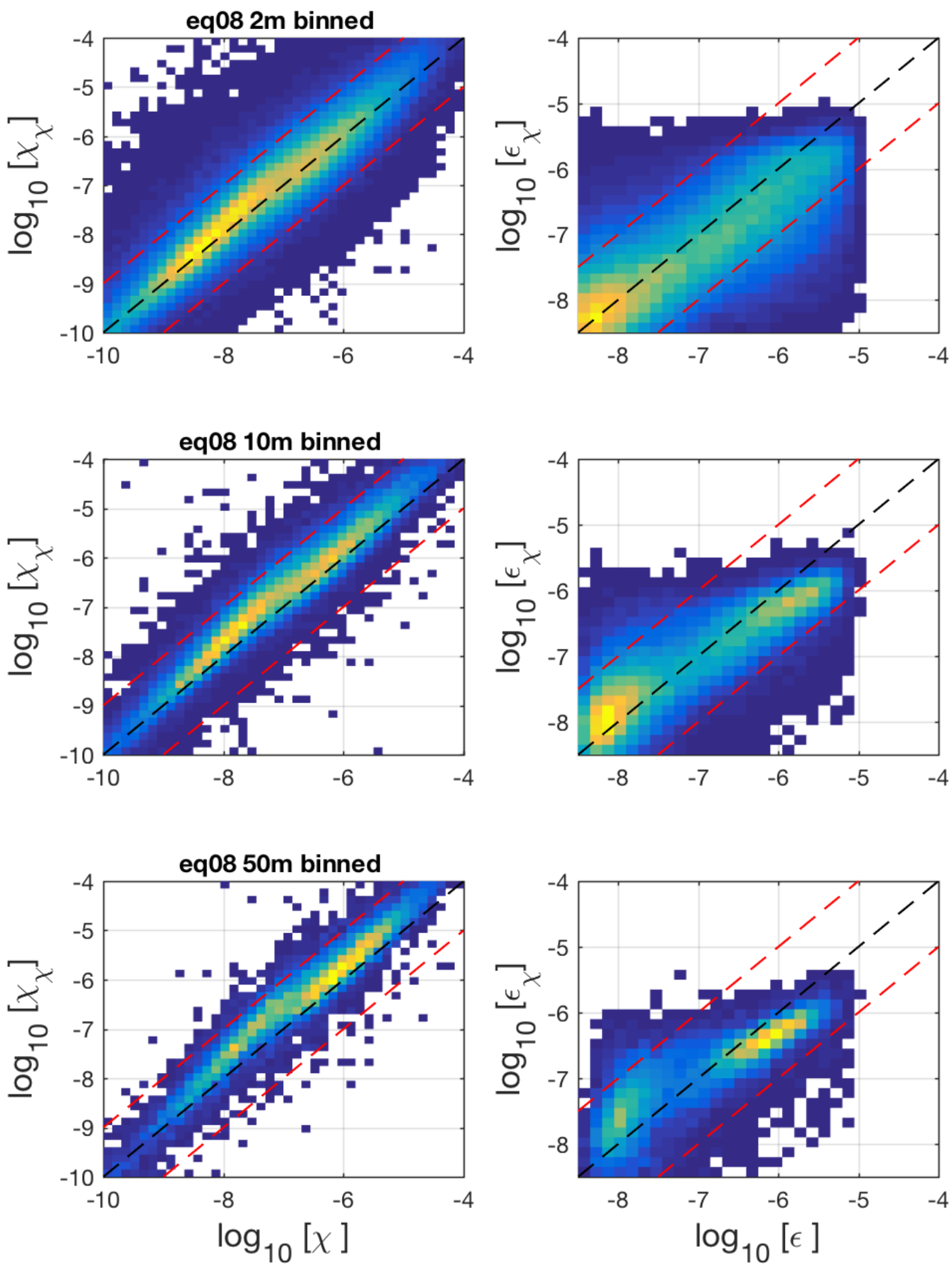

Figure 11: 2D Histograms of χ_{chi} vs χ (left) and ϵ_χ vs ϵ (right) averaged over different size depth bins

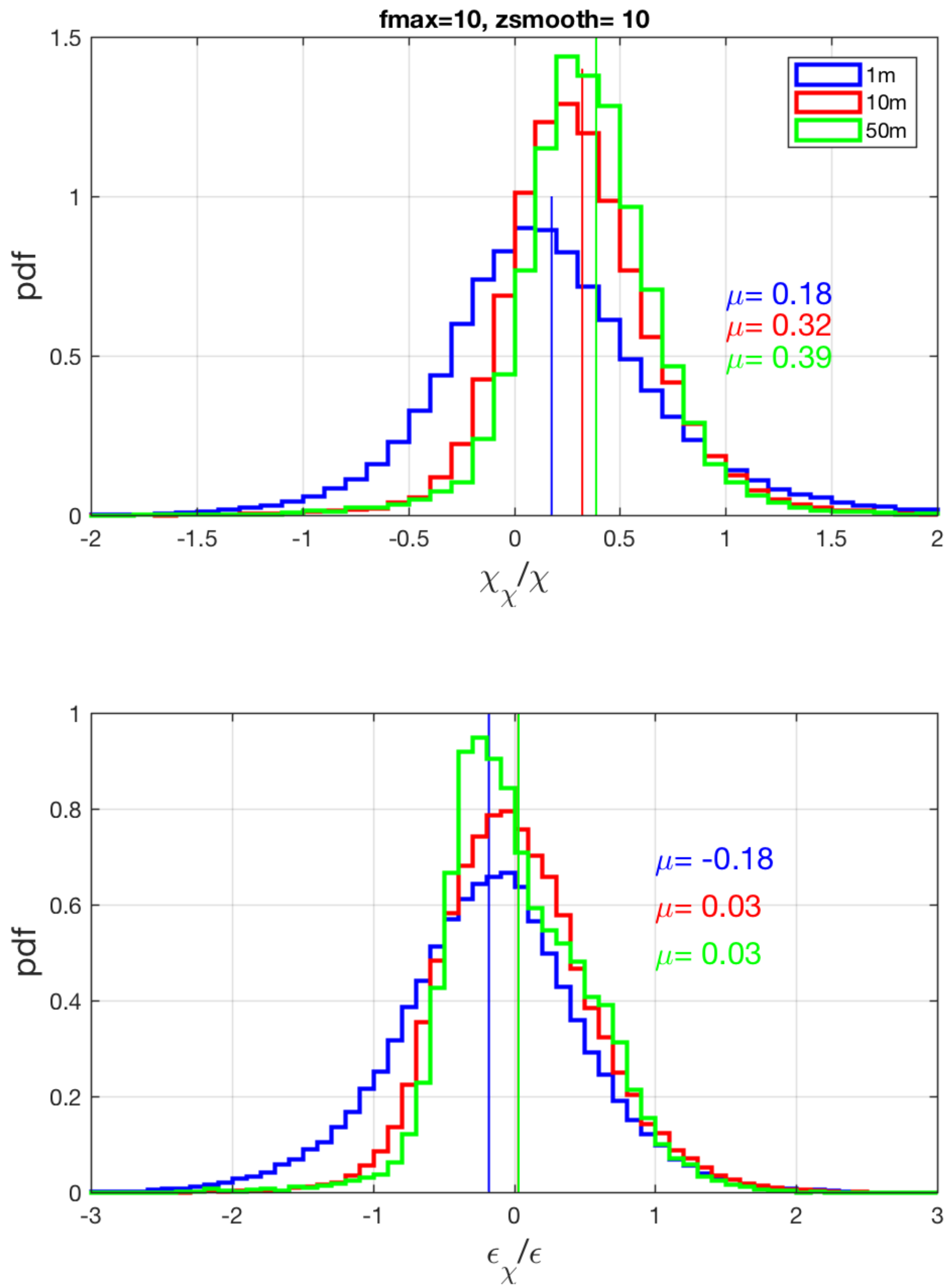

Figure 12: Histogram of log10 of ratio ϵ_χ/ϵ for different amounts of vertical averaging. Vertical lines are mean of $log_{10}[\epsilon_\chi/\epsilon]$ for each distribution.