Summary of χpod Chameleon EQ14 Analysis

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1 Overview

- This document is an attempt to provide an overview/summary of what i've found in my χpod analysis.
- The motivation/goal for all this work is to show if and how well the CTD-χpod method works for estimating χ,ϵ, K_T, etc from fast temperature profiles.
- Before dealing with all the issues with the CTD deployments (depth loops, entraining water, rosette-induced turbulence), 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 (ϵ_χ), and compare to the 'true' results computed using the shear probes (ϵ).
- I found that basically the estimates of χ agreed, but ϵ_χ was about an order of magnitude smaller than ϵ (Figure 1,2,3).
- The χpod method requires an assume mixing efficiency, and uses the normal assumption that $\gamma = 0.2$. I computed gamma from the chameleon data (formula) and found that it was about an order of magnitude smaller than 0.2; hence the low epsilon estimates.
- Is gamma really different here? Am I calculating it wrong? What does gamma mean? Sasha found something similar previously, gives me a little more confidence that i'm not doing something wrong..
- One idea was that we should be computing gamma over patches, and it's meaningless outside of patches. Previous work has found gamma is close to 0.2 . So I tried computing patches and gamma. This can be a whole other can of worms (lots of choices to make in how to identify patches, compute N2, Tz etc), but I found I could get gammas close to 0.2 . And on a point-by-point basis, ϵ_χ agreed better with ϵ_χ. But then we have much fewer data points...
- Looked at whether averaging multiple profiles agreed better. Doesn't seem to make epsilon agree. However, gamma computed from average quanitites is closer to 0.2?
- So, is gamma really small here, or am I just computing it wrong? Look at other locations/regimes?

2 Data and Processing

- `ComputeChi_Chameleon_Eq14.m` : Applies χpod method to Chameleon profiles from EQ14.
- Sally shared w/ me Chameleon data that she and Jim processed. I ended up re-processing it using a smaller fmax (7Hz) because it looked like the thermistor spectra rolled off much lower than the assumed 32Hz.

3 ?

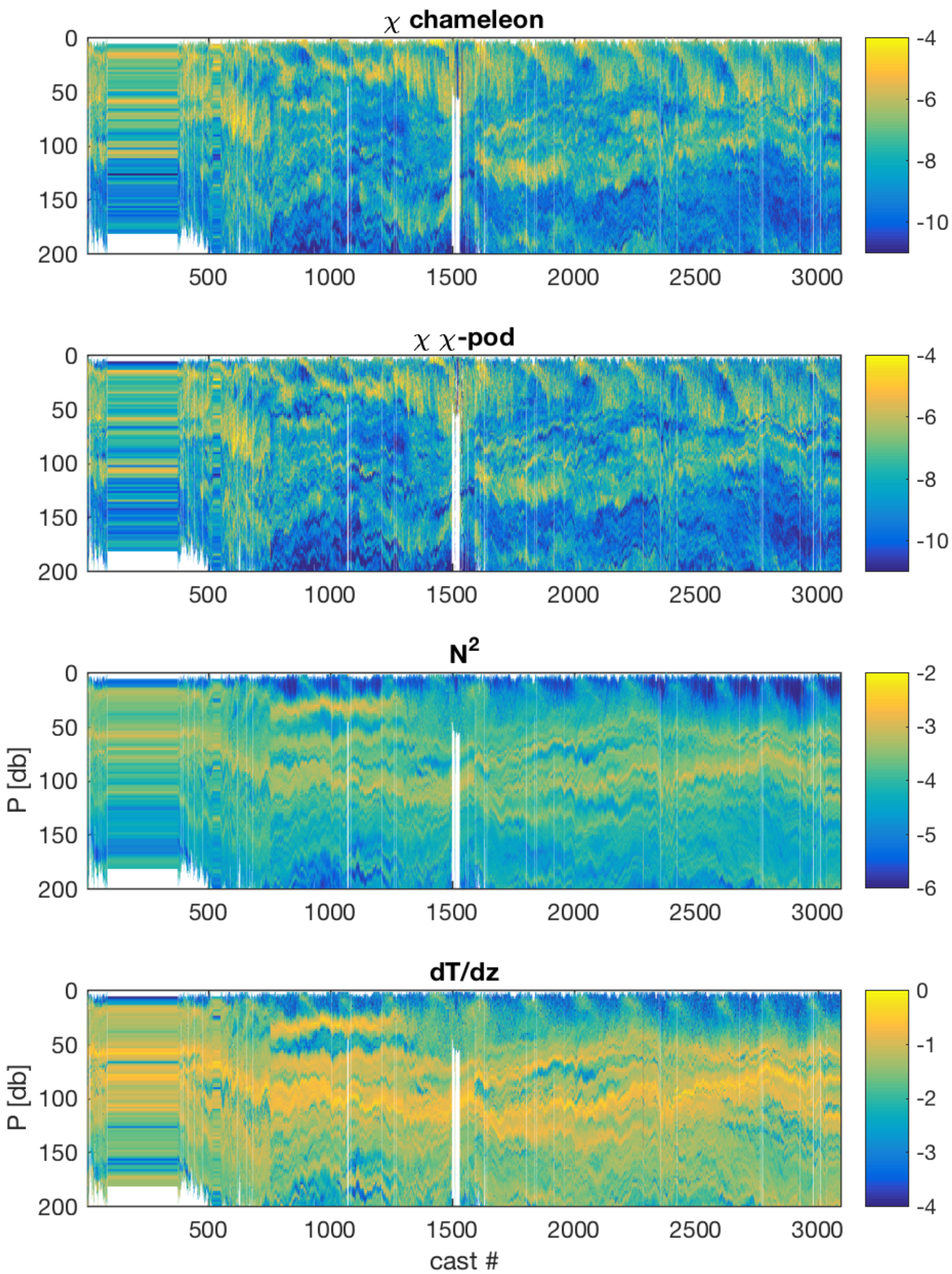


Figure 1: Comparison of χ from chameleon method and chi-pod method, for EQ14 chameleon profiles. Each profile was averaged in 2m bins.

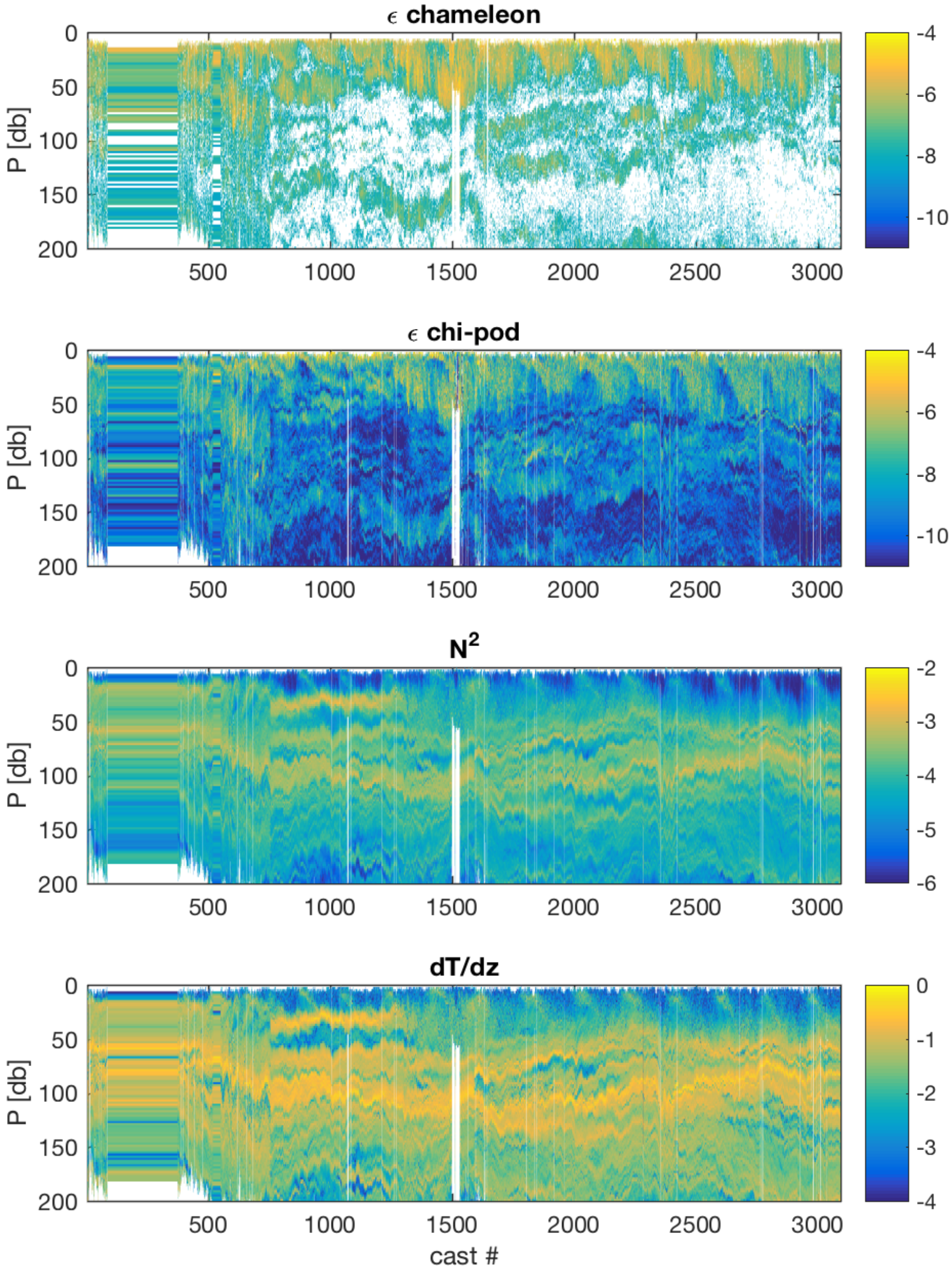
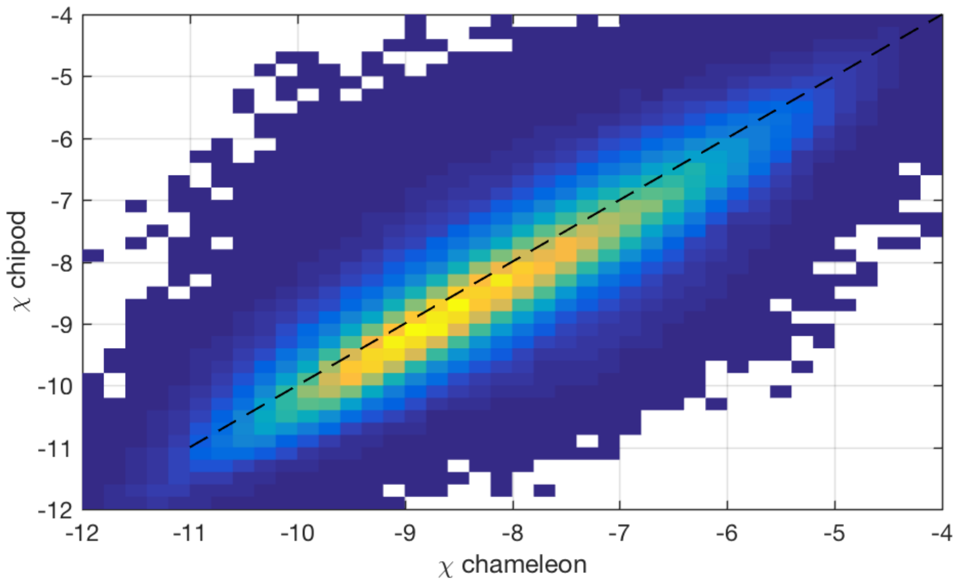


Figure 2: Comparison of ϵ from chameleon method and chi-pod method, for EQ14 chameleon profiles. Each profile was averaged in 2m bins. Values of below chameleon noise floor (-8.5) have been naned out



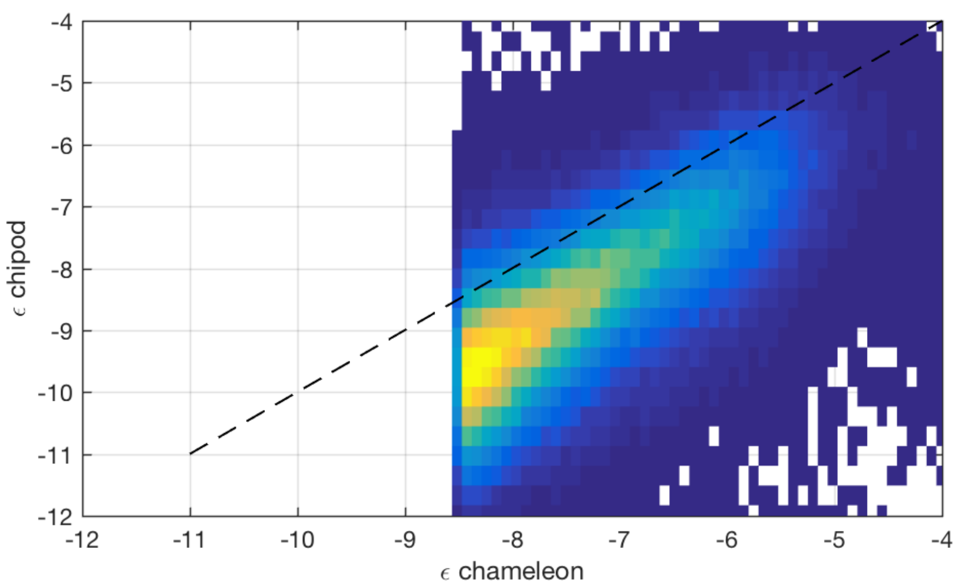


Figure 3: Comparison of χ ϵ from chameleon method and chi-pod method, for EQ14 chameleon profiles. Each profile was averaged in 2m bins. Values of below chameleon noise floor (-8.5) have been naned out

4 Comparing individual estimates of ϵ

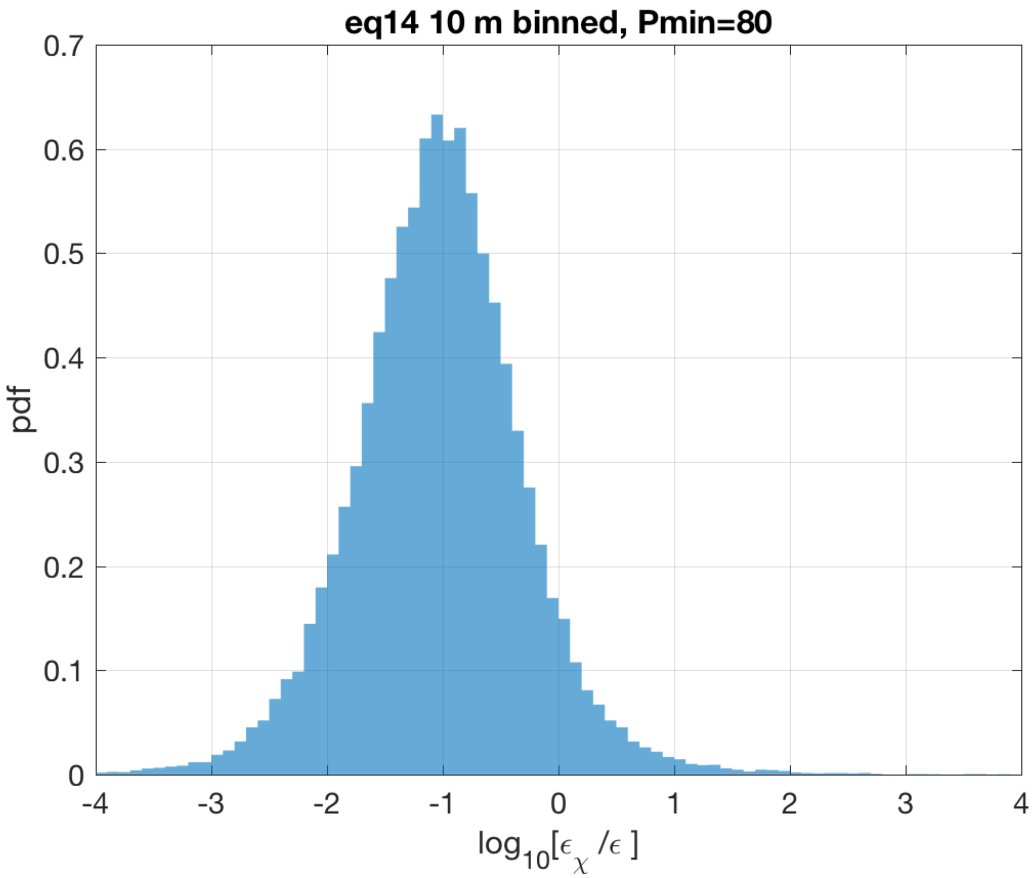


Figure 4: EQ14: Histogram of the ratio of ϵ estimates from χpod method to the chameleon values, for χpod method applied to 1m binned profiles, and applied to just patches. Estimates for each profile were averaged in 10m depth bins.

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.

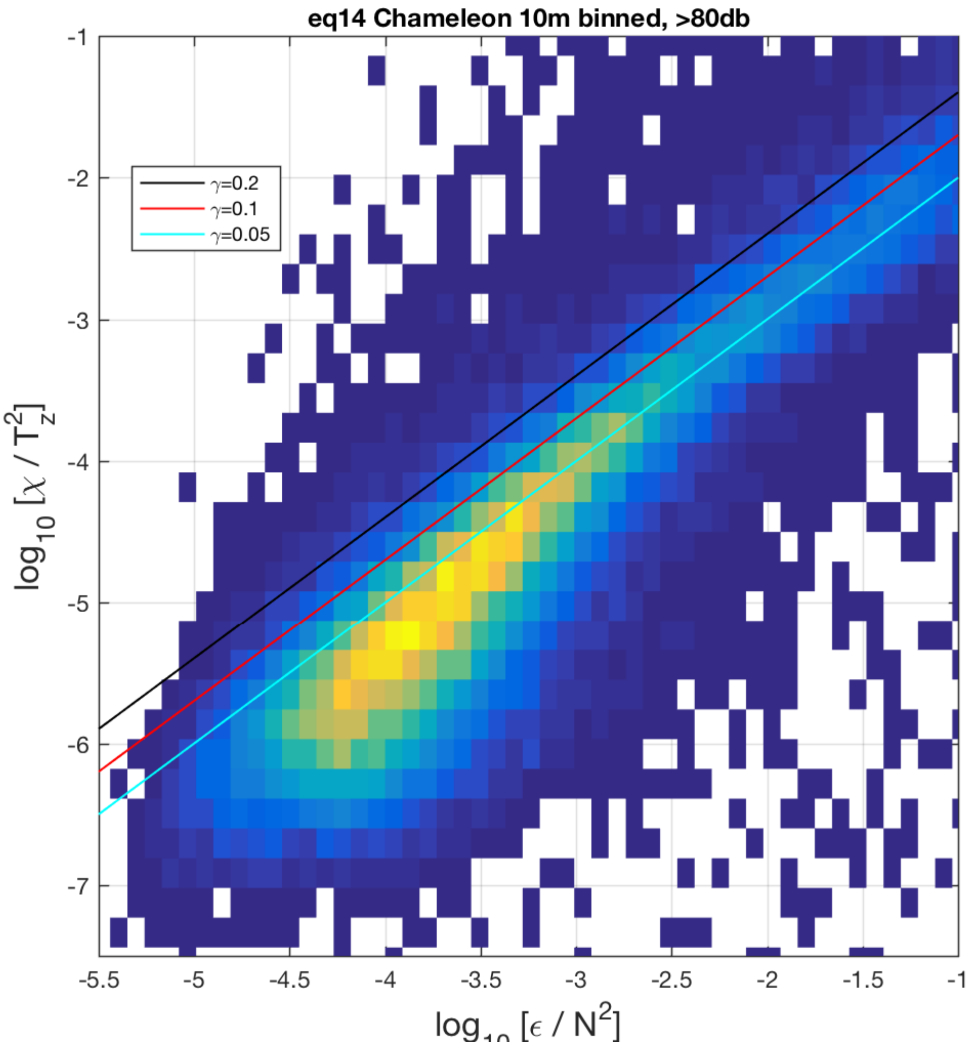


Figure 5: EQ14: 10m binned chameleon $\epsilon/N\hat{2}$ vs χ/t_z^2 for *below 80db*. Lines show different values of γ. Values of ϵ below noise floor ($log_{10}\epsilon < -8.5$) are discarded also.

6 Averaging many profiles of ϵ

Figure 6 shows one example. A folder with many profiles is located at: `https://github.com/OceanMixingGroup/Analysis/tree/master/Andy_Pickering/eq14_patch_gamma/figures/chi_eps_profiles_40profavgs`. In general, it seems that averaging profiles does not change the comparsion much; ϵ_χ is still biased low.

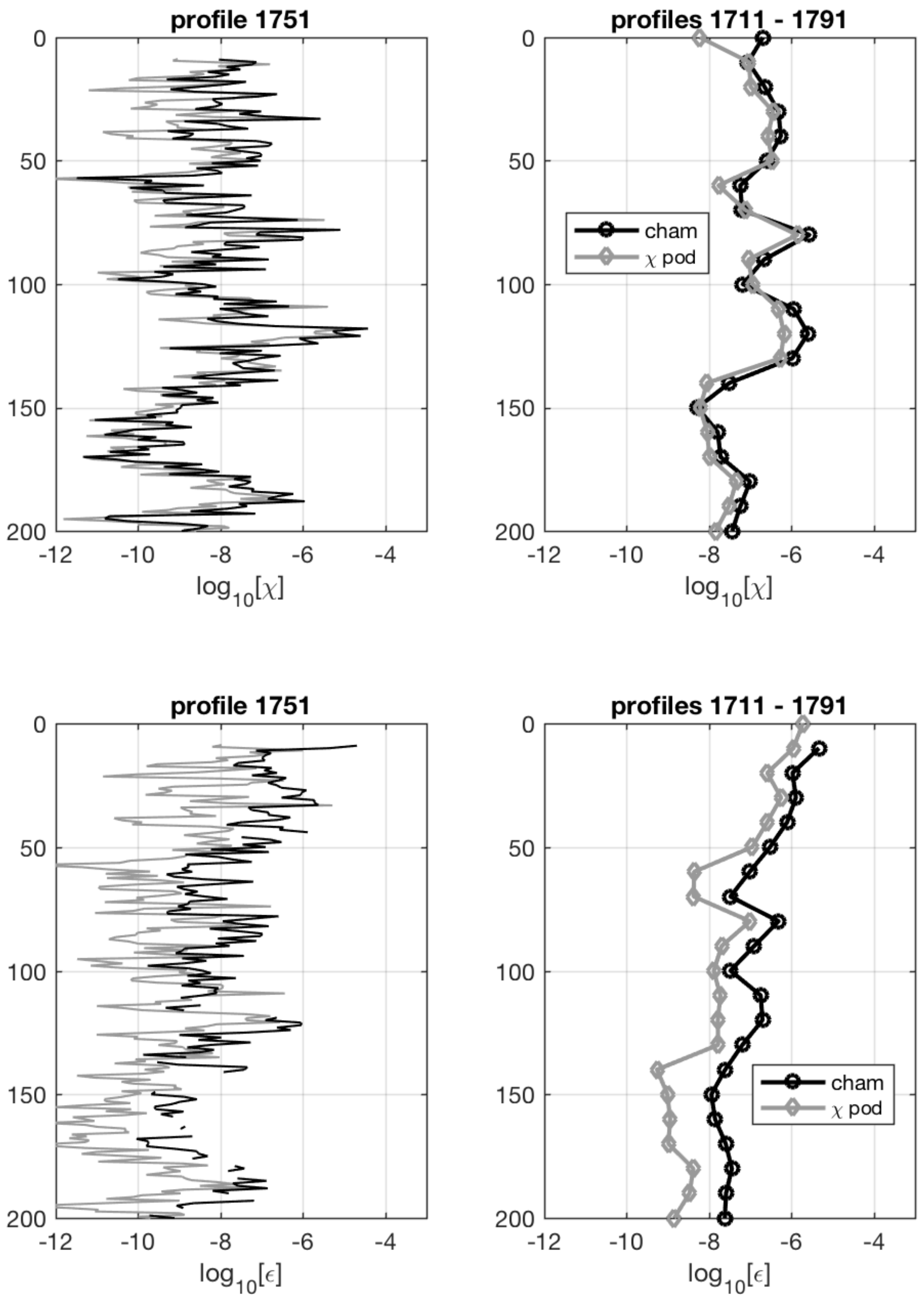


Figure 6: Example of averaging multiple profiles together. Left panels show a single profile from chamleeon and chi-pod method. Right panels show average of $+/-$ 40 profiles, averaged in 10m depth bins.

7 Effects of averaging in different-sized depth bins

I tried making plots of normalized chi vs eps, and scatterplots of chi-pod vs chameleon epsilon, for data averaged in different-sized depth bins (for each profile, not across profiles). They don't seem to change.

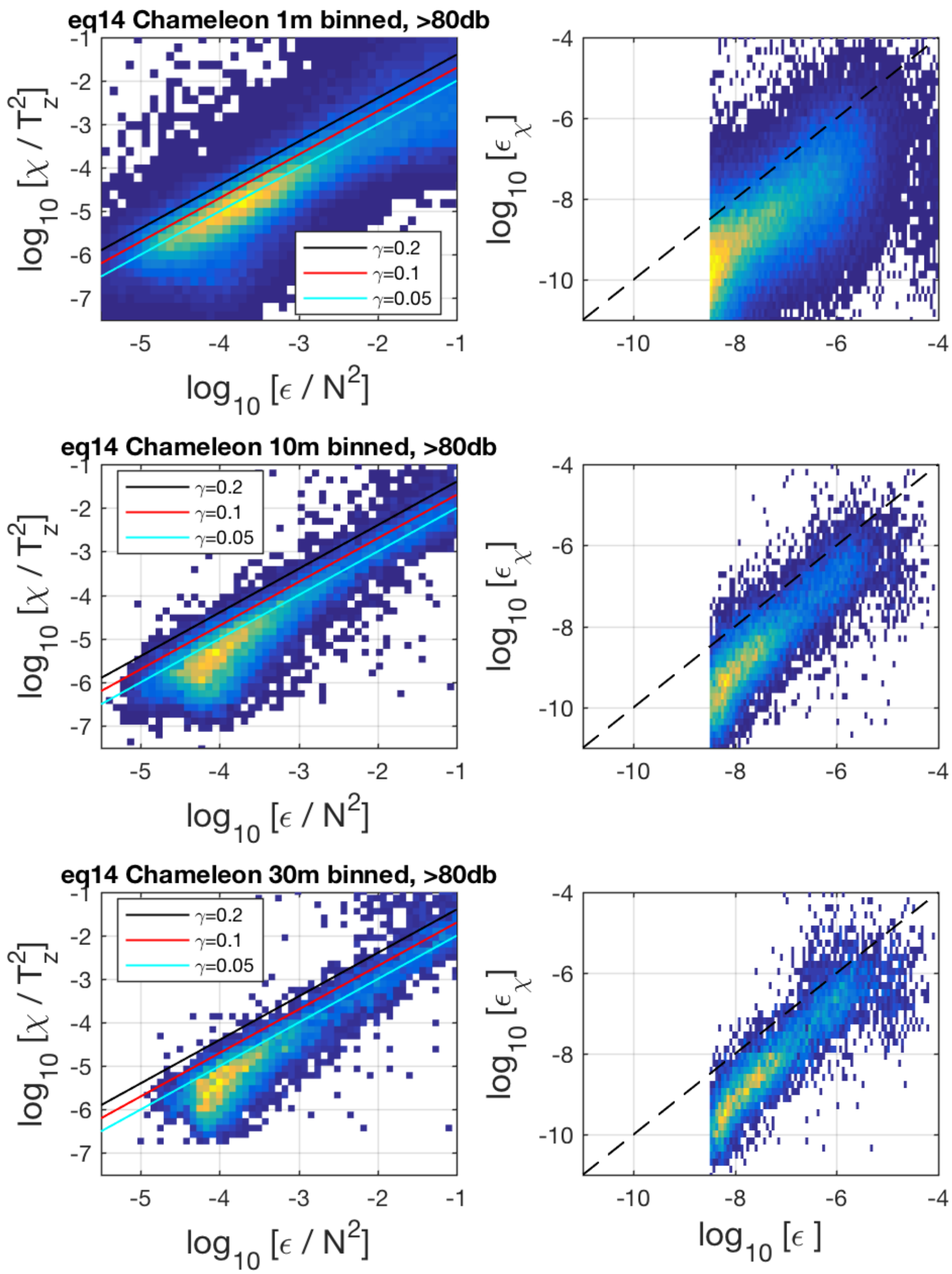

eq14 Chameleon 1m binned, >80db
γ=0.2
γ=0.1
γ=0.05
eq14 Chameleon 10m binned, >80db
eq14 Chameleon 30m binned, >80db
$\log_{10} [\chi / T_z^2]$
$\log_{10} [\epsilon / N^2]$
$\log_{10} [\epsilon_\chi]$
$\log_{10} [\epsilon]$

Figure 7:

8 Effects of averaging different numbers of profiles

I tried making plots of normalized chi vs eps, and scatterplots of chi-pod vs chameleon epsilon, for data averaged across different numbers of profiles. This doesn't seem to change either, which is strange because it looked like when I plotted average profiles they were matching better for more averaging....

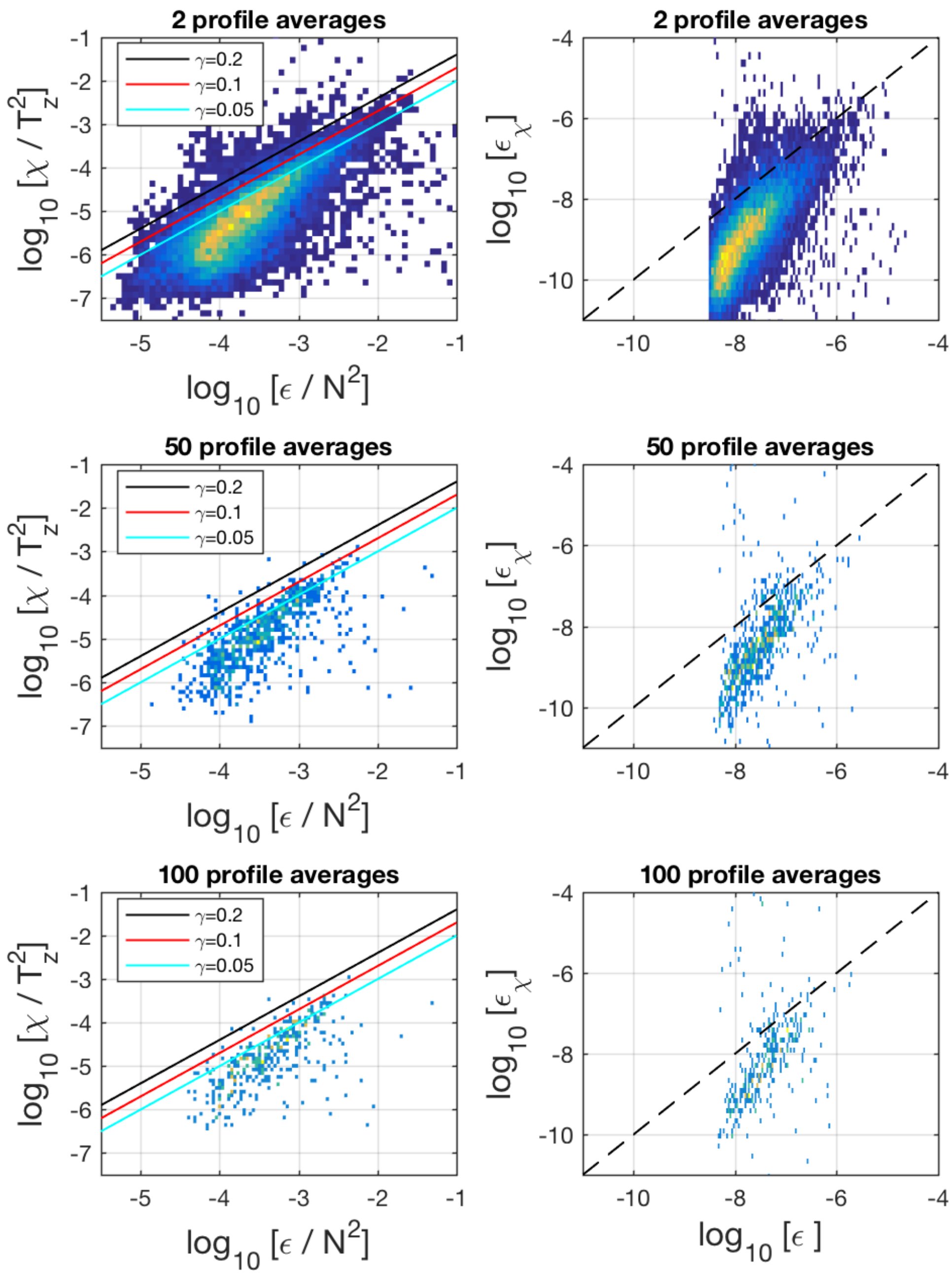

2 profile averages
γ=0.2
γ=0.1
γ=0.05
$\log_{10} [\chi / T_z^2]$
$\log_{10} [\epsilon / N^2]$
$\log_{10} [\epsilon_\chi]$
50 profile averages
100 profile averages
$\log_{10} [\epsilon]$

Figure 8:

9 γ computed from averaged quantities

If we compute gamma from time-averaged N^2, T_z, χ, ϵ do we get $\gamma = 0.2$ (or a different gamma)? Estimates from the averaged data are larger (Figures **??**,9) but still slightly less than 0.2 .

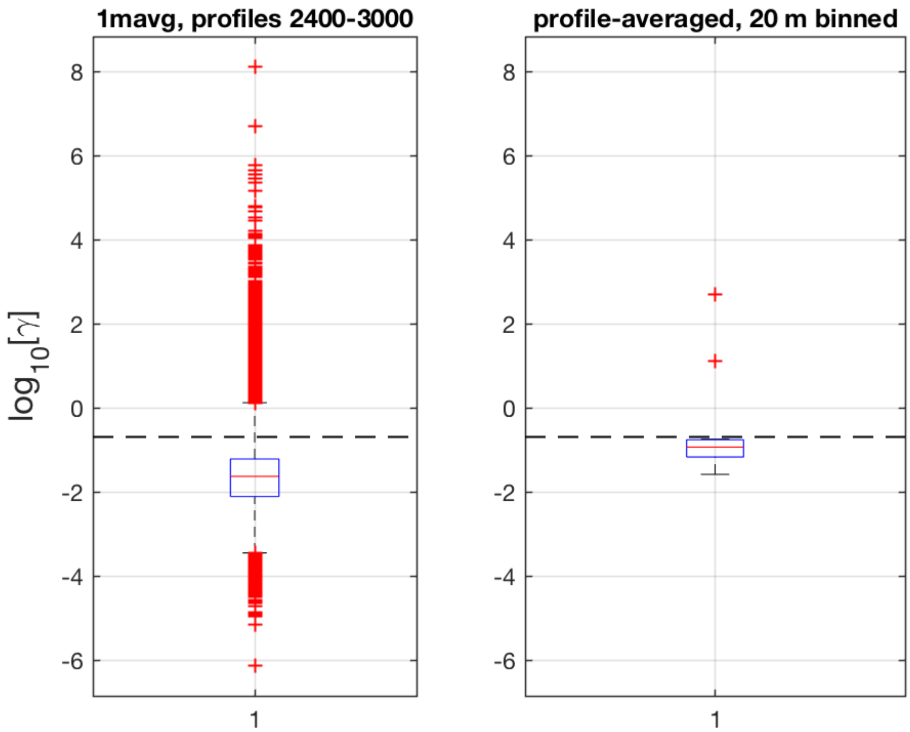


Figure 9: Boxplots of $log_{10}[\gamma]$ for a set of profiles from EQ14. Left is for all 1m avg data. Right is for data from all profiles averaged in 10m bins. Horizontal dashed line indicates $\gamma = 0.2$.

10 Summary

- Inidivudal (and 10m binned) χpod estimates of ϵ are biased low compared to Chameleon values.
- γ computed from averaged (across profiles) N^2, T_z, χ, and ϵ is larger, but not quite 0.2 (mean is around 0.1?)