Patch/Gamma Analysis for EQ14 chameleon patches

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Contents

1 Overview

The goal of this analysis is to compute mixing 'coefficient' $\gamma_{\chi\epsilon} = \frac{N^2\chi}{2\epsilon T_z^2}$ for patches in EQ14 chameleon profiles, and see if we obtain values close to $\gamma_{\chi\epsilon} = 0.2$. A similar analysis was done for TIWE data. The motivation for this analysis came from working on CTD-χpod data; the method assumes $\gamma = 0.2$, but it was found for some (1m binned) data this was not true. Therefore the method might need to be applied to patches instead.

2 Data

Data are made by the 'Chameleon' microstructure profiler near the equator during the 'EQ14' experiment. The data was shared with me by Sally/Jim. My copy is located at :

`/Users/Andy/Cruises_Research/ChiPod/Cham_Eq14_Compare/`

Chameleon data already processed by Sally is in :
`/Users/Andy/Cruises_Research/ChiPod/Cham_Eq14_Compare/Data/chameleon/processed/`

This analysis is in the main folder:
`/Users/Andy/Cruises_Research/Analysis/Andy_Pickering/eq14_patch_gamma/` . This is also a github repository.

3 Methods

- `FindPatches_eq14_Raw.m` Identifies patches in the profiles made by `Process_tiwe_rawprofiles_AP.m`, using potential temperature.
- `Compute_N2_dTdz_patches_eq14_eachcast.m` Computes N^2 and T_z for patches, using several different methods. SAves results in a structure 'patches'.
- `add_binned_to_patches.m`
- `run_eq14_for_PATCHES.m` Runs the Chameleon processing (including χ and ϵ) for just the patches identified in `FindPatches_eq14_Raw.m` . This calls `average_data_PATCH_AP.m` instead of `average_data_gen1.m`.
- `add_patch_chi_eps_to_patches_eq14_each_profile.m` Adds χ and ϵ comptued over patches (in `run_eq14_for_PATCHES.m`) to patch profiles.
- `combine_patch_profiles_eq14.m` Combines all patch profiles into 1 structure.

3.1 dTdz

Temperature gradient is computed for each patch using the following methods:

1. $dtdz_{line}$: Fit a straight line to sorted T using `polyfit`

2. $dtdz_{bulk}$: Use the 'bulk gradient' from Smyth et al 2001, which is the rms fluctuation from the background (sorted) temperature, divided by the thorpe scale (the rms re-ordering distances).

3.2 N2

N^2 is computed for each patch using the following methods:

1. N^2_{line} : Fit a straight line to sorted potential density using polyfit to get $d\rho/dz$, then compute N2.

2. N^2_{bulk} : Use 'bulk gradient' . This is calculated from the bulk T_z, using a linear fit between density and temperature.

3. N^2_4 : Compute N^2 from the sorted profile (sorted by potential density) using `sw_bfreq`, then take average over the patch. I believe this method is used by some commonly-used overturn codes.

3.3 Mixing Efficiency

Mixing Efficiency $\gamma_{\chi\epsilon}$ is computed from the following equation using differerent N^2 and dT/dz values.

$$\gamma_{\chi\epsilon} = \frac{N^2\chi}{2\epsilon T_z^2} \tag{1}$$

χ and ϵ are computed over each patch from the Chameleon data. Gamma is computed for the following 4 combinations:

1. γ_{bin} : 1m binned data interpolated to patch depths.

2. γ_{line} : N^2_{line}, $dtdz_{line}$

3. γ_{bulk} : N^2_{bulk}, $dtdz_{bulk}$

Values where ϵ is below the noise floor of $log_{10}[\epsilon] = -8.5$ are discarded.

4 Results

- $\gamma_{\chi\epsilon}$ computed for 1m avg ('binned') data is about an order of magnitude less than 0.2 (Figure 2). It has a median value of $\gamma = 0.015$ for data between 60-200m. The data was processed by Sally w/ 2 different c-star values, this doesn't seem to make any difference in the estimated $\gamma_{\chi\epsilon}$.
- $\gamma_{\chi\epsilon}$ computed for just patches (Figure 3) varies depending on which method is used. The 'line' and 'bulk' methods have median values around $\gamma = 0.1$. The bin and line-fit estimates are much smaller than 0.2

Table 1: Statistics for patches using various parameters. γ values are medians for each distribution. Only patches between 60-200m are considered.

minOT	usetemp	minR2	γbin	$\gamma line$	γfit	$\gamma bulk$	Npatches
0.4	1	0	0.03	0.15	0.02	0.13	9326
0.4	1	0.5	0.03	0.09	0.02	0.08	1301
0.75	1	0	0.05	0.13	0.02	0.12	4075
0.75	1	0.5	0.05	0.08	0.03	0.08	520
1	1	0	0.06	0.12	0.02	0.12	2829
1	1	0.5	0.05	0.08	0.04	0.08	387

4.1 Using smaller fmax?

I believe the Chameleon data processed by Sally used the standard fmax=32Hz correction/cutoff for the thermistor data. However when I was trying to apply the χpod method to that data, I looked at some spectra and it looked like the thermistor rolled off much lower, around maybe 7-10hz. So I re-ran the processing using fmax=7hz. Estimates of $\gamma_{\chi\epsilon}$ are about 2-3 times larger (Figure 4), but still significantly less than 0.2 .

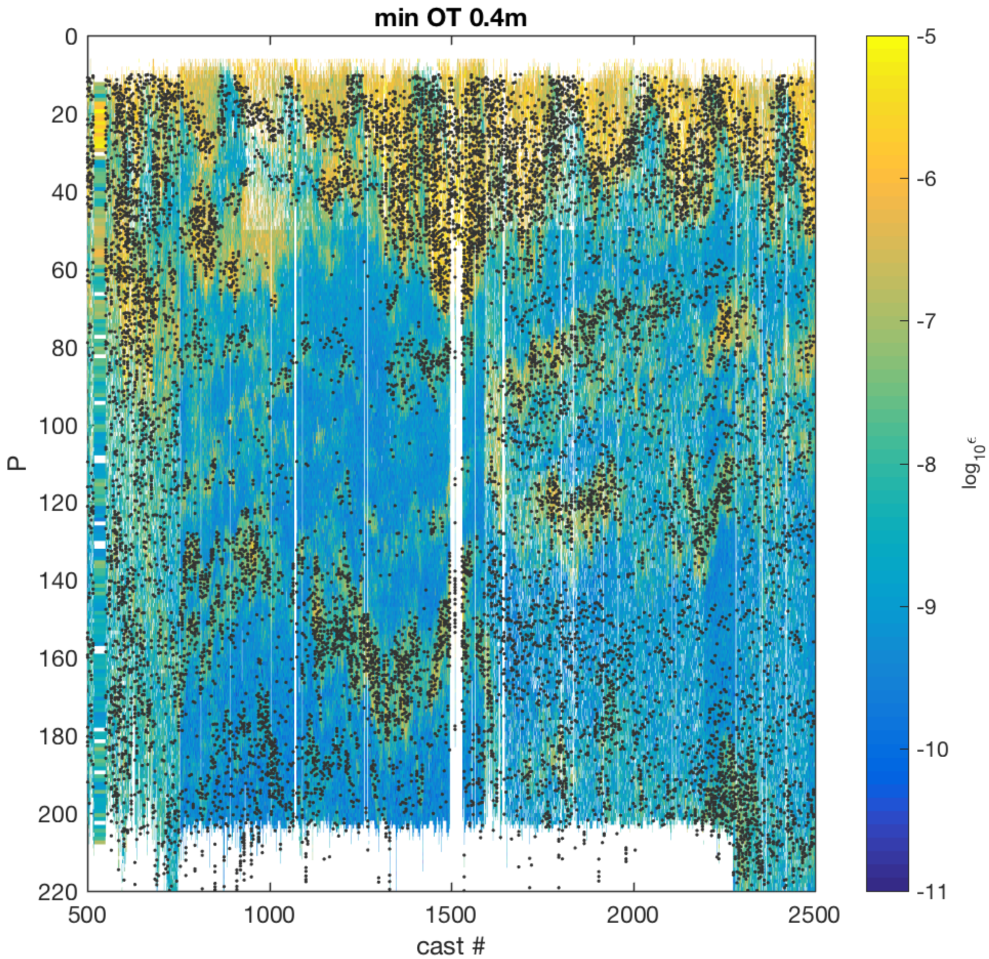

Figure 1: Patch locations (mean depth) plotted on top of epsilon.

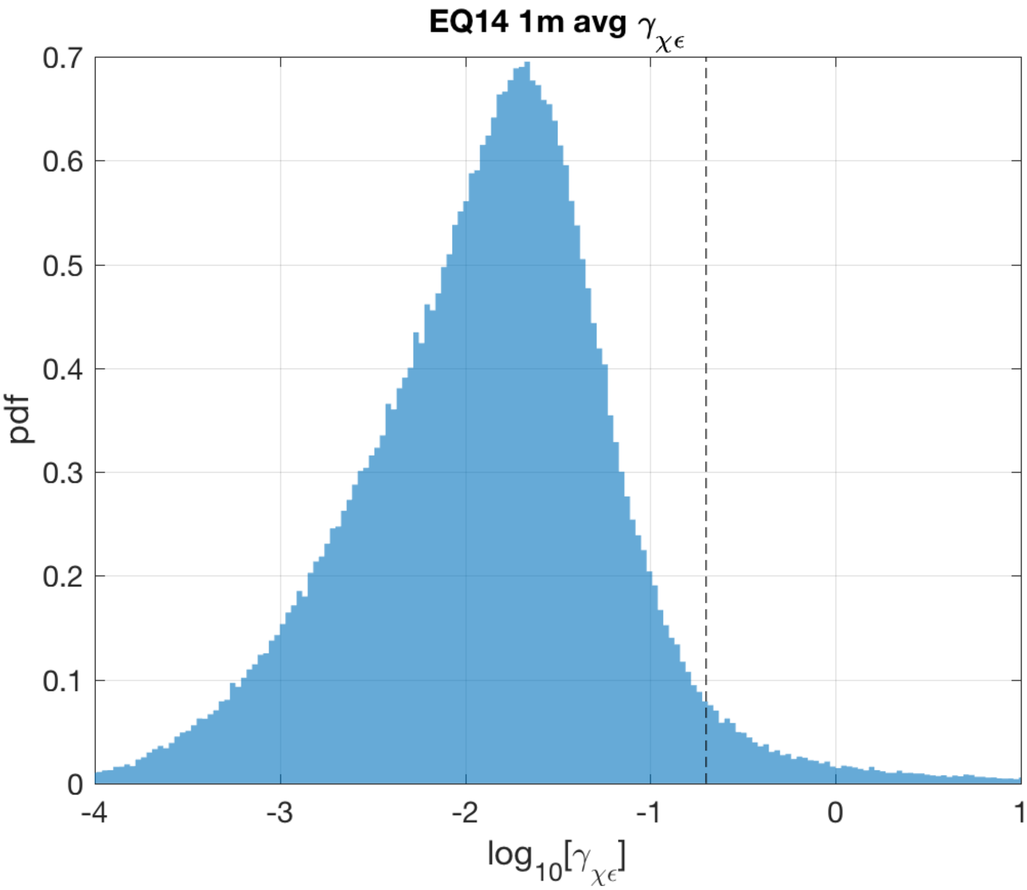

Figure 2: Histogram of $\gamma_{\chi\epsilon}$ for 1m avg chameleon profiles between 60-200m depth. Vertical dashed line shows $\gamma = 0.2$.

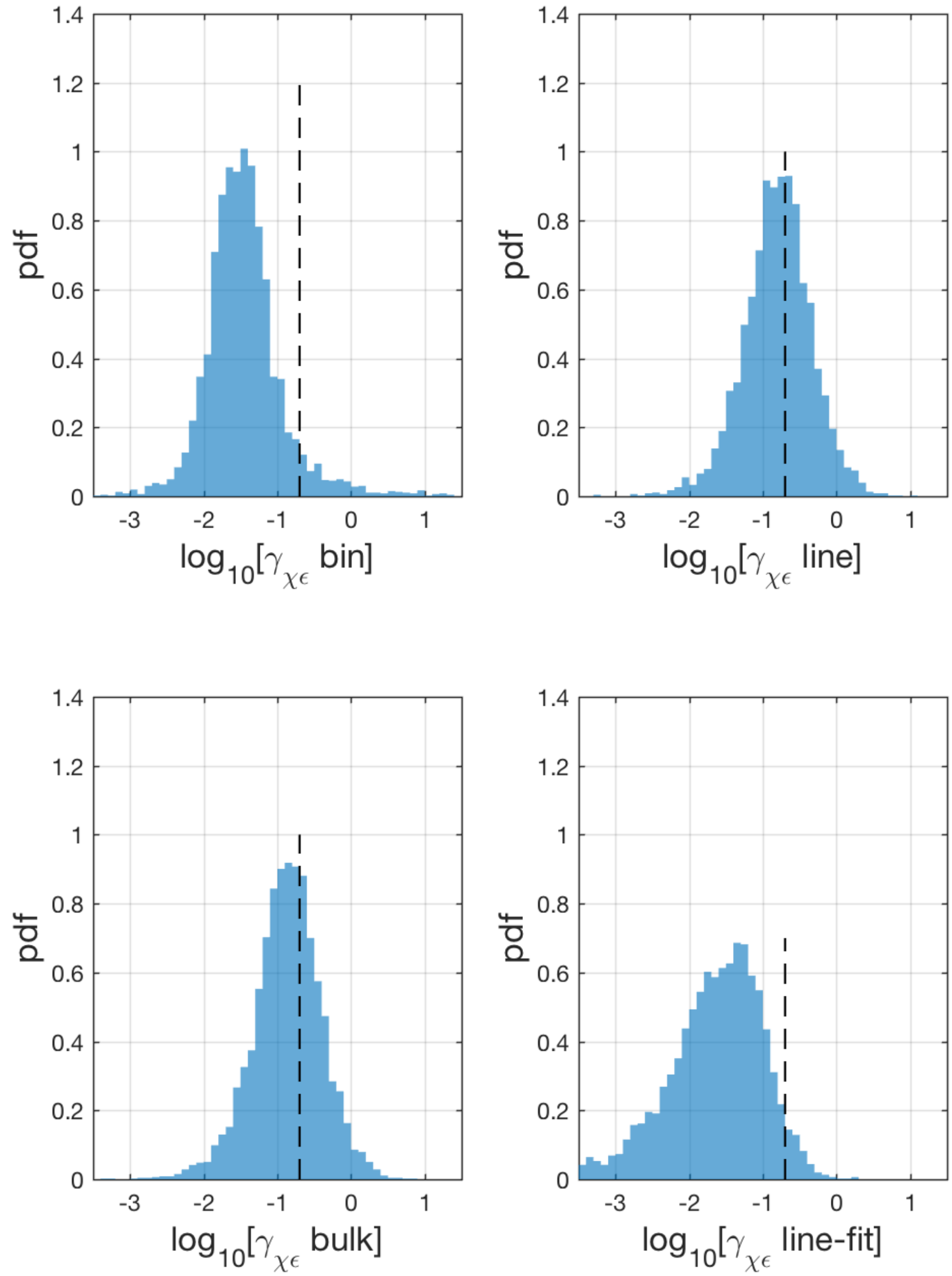

Figure 3: Histogram of $\gamma_{\chi\epsilon}$ for patches, using different estimates of N^2 and T_z. Vertical dashed line shows $\gamma = 0.2$. For all profiles, all depths.

eq14_binned_gamma_7hz.png

Figure 4: Histogram of $\gamma_{\chi\epsilon}$ for 1m avg chameleon profiles, for standard fmax32hz as well as fmax7hz. Vertical dashed line shows $\gamma = 0.2$.

4.2 Variation of $\gamma_{\chi\epsilon}$ with epsilon

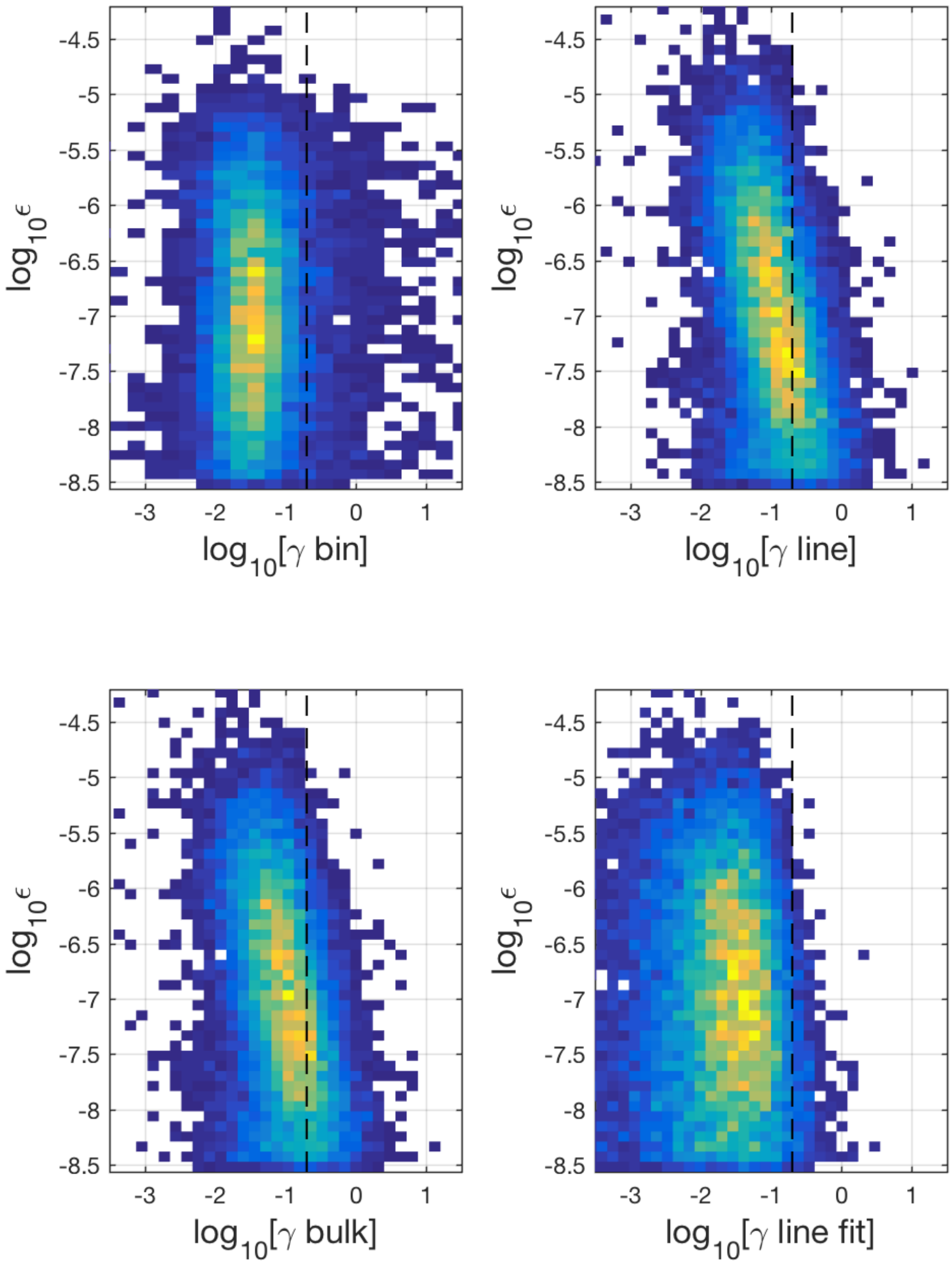

Figure 5: Plot of $\gamma_{\chi\epsilon}$ for patches vs epsilon Vertical line is $\gamma = 0.2$.

4.3 Variation of $\gamma_{\chi\epsilon}$ over time

To investigate whether $\gamma_{\chi\epsilon}$ varies over time, I plotted $\gamma_{\chi\epsilon}$ vs cast number (Figure 6).

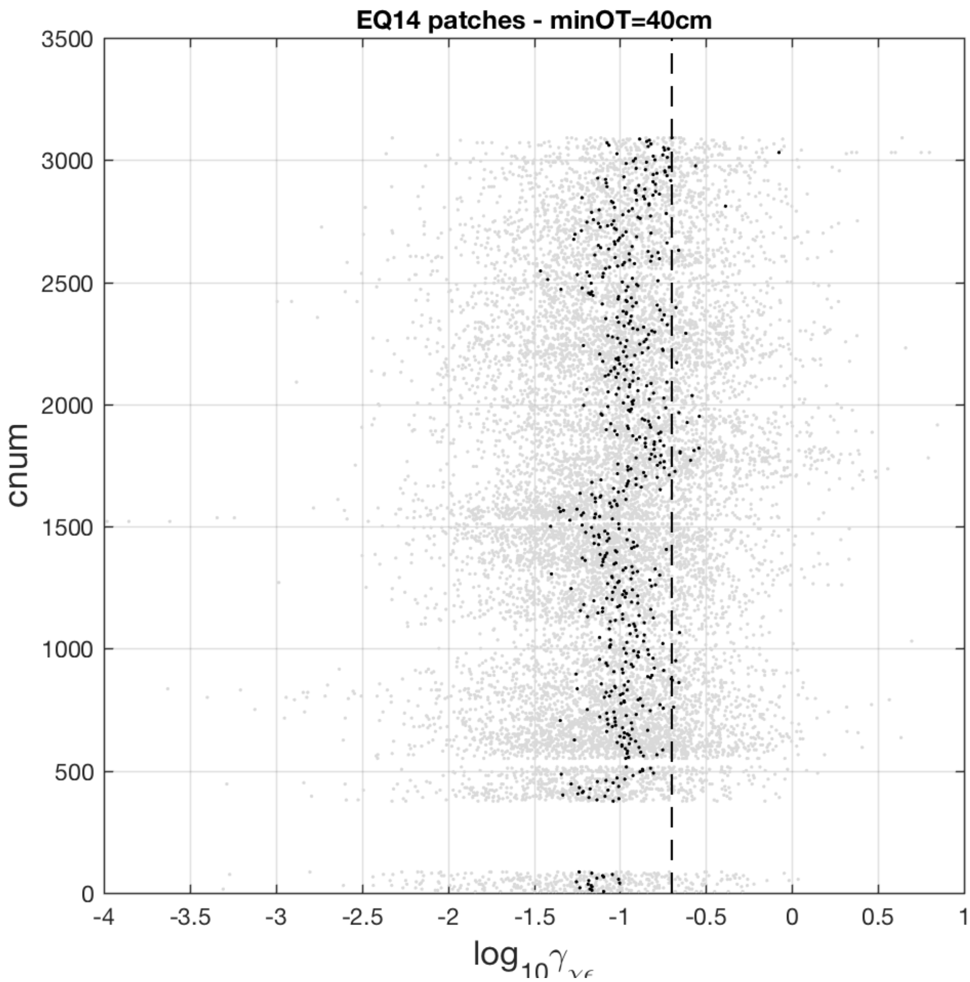

Figure 6: Plot of $\gamma_{\chi\epsilon}$ for patches vs cast number. Vertical line is $\gamma = 0.2$. Black points are the median value for each cast.

4.4 Variation of $\gamma_{\chi\epsilon}$ over depth

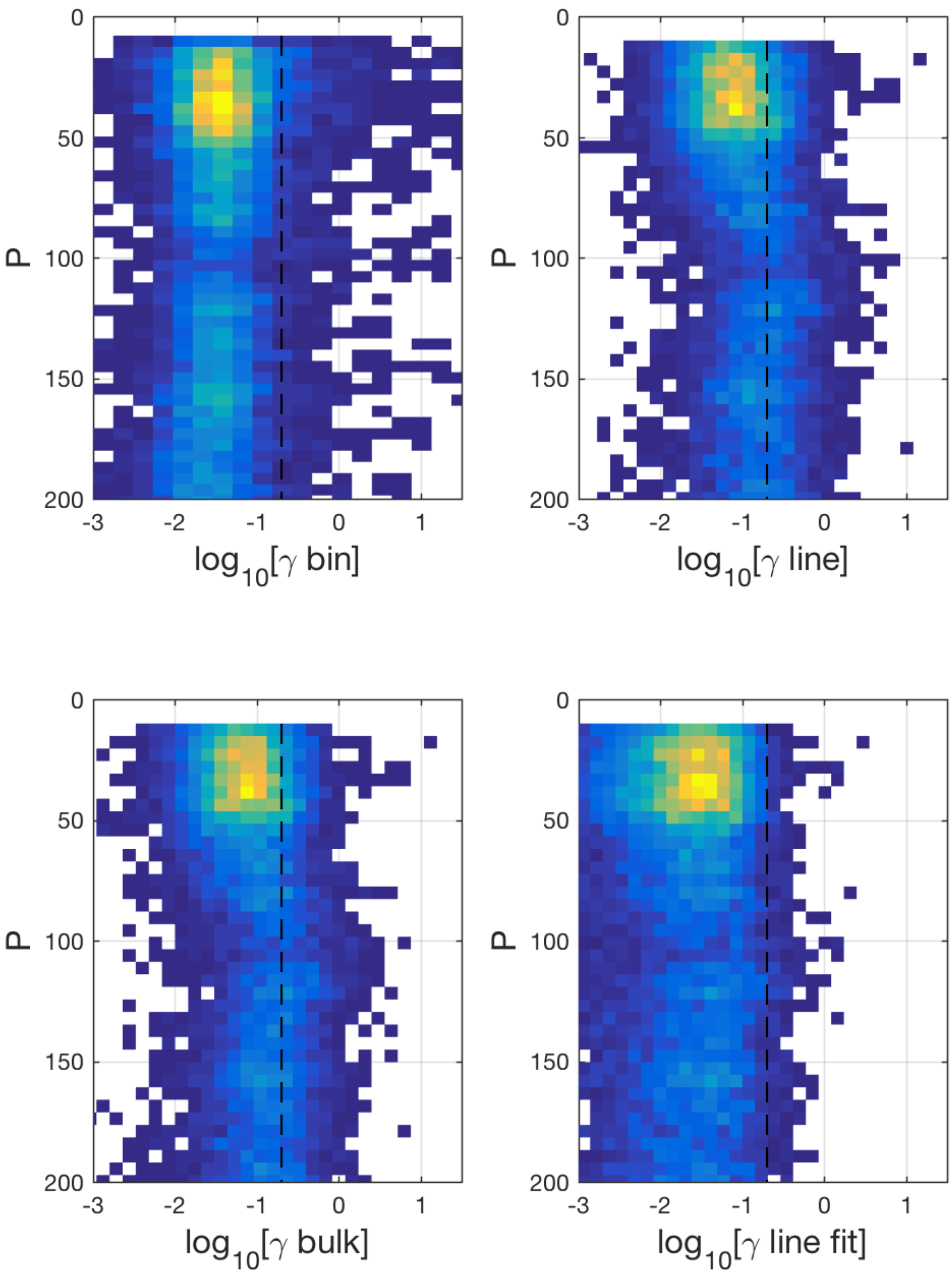

Figure 7: Plot of $\gamma_{\chi\epsilon}$ for patches vs depth. Vertical line is $\gamma = 0.2$.

5 Summary

- $\gamma_{\chi\epsilon}$ computed from 1m binned data (the standard Chameleon processing) is about 10 times smaller than the typical assumed value of 0.2.

- $\gamma_{\chi\epsilon}$ computed for just patches varies depending on what method of choosing T_z and N^2 is used. The 'line' and 'bulk' methods give γ estimates close to 0.1.