

# EQ14 - Computing gamma by patches

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## 1 Intro

\* These notes follow code `Compute_gamma_by_patches.m`

In this analysis I'm trying to compute  $\Gamma$  for EQ14 Chameleon data by patch instead of just at every point. The equation used is

$$\Gamma = \frac{N^2 \chi}{2\epsilon < dT/dz >^2} \quad (1)$$

Figure 1 shows the distribution of estimated gammas using all the chameleon data, and using just the data between 60 and 180m depth. The median gamma from both is about 0.02, about ten times smaller than the usually assumed  $\Gamma = 0.2$ .

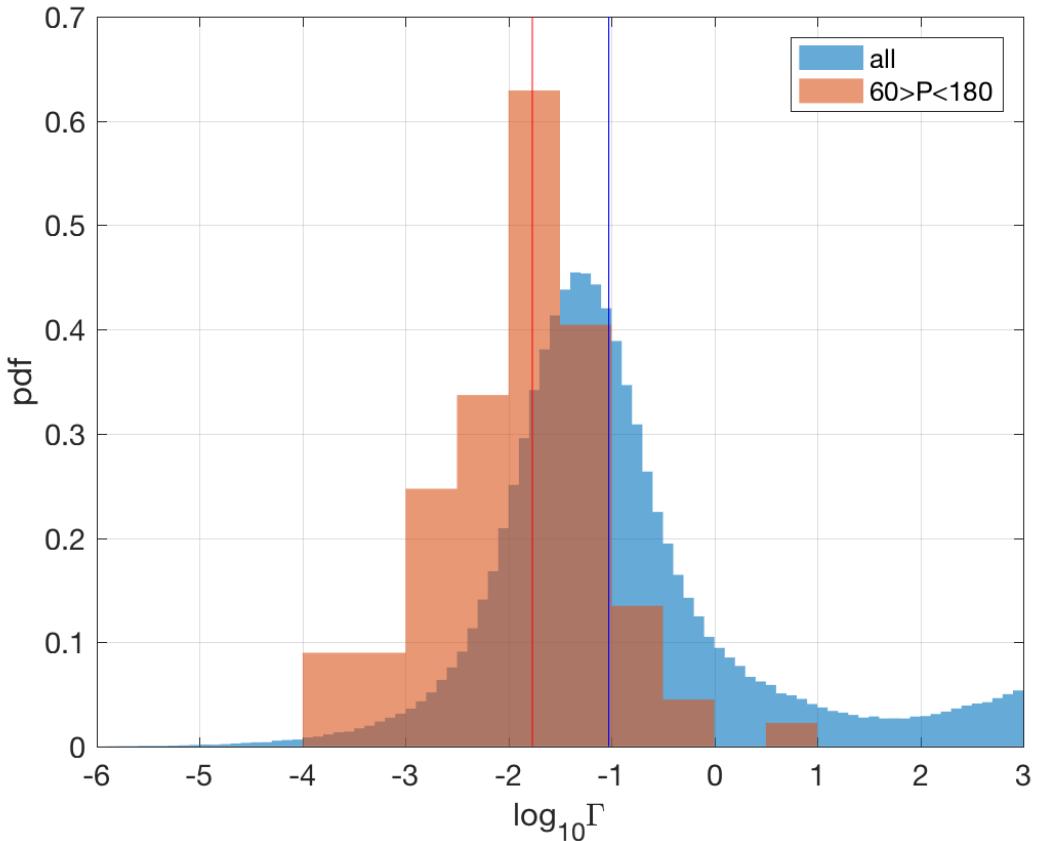


Figure 1: Histogram of  $\Gamma$  for all EQ14 chameleon profiles.

## **2 Looking at stratification etc.**

Looking in more detail at relationships between straitification,  $\chi$ , and  $\Gamma$  as suggested by Emily. See `MakeEmilysPlot.m`. Figure 2 shows 2-D histograms of gamma vs each variable. Figure 3 shows the mean and median values of gamma for bins of chi vs N2.

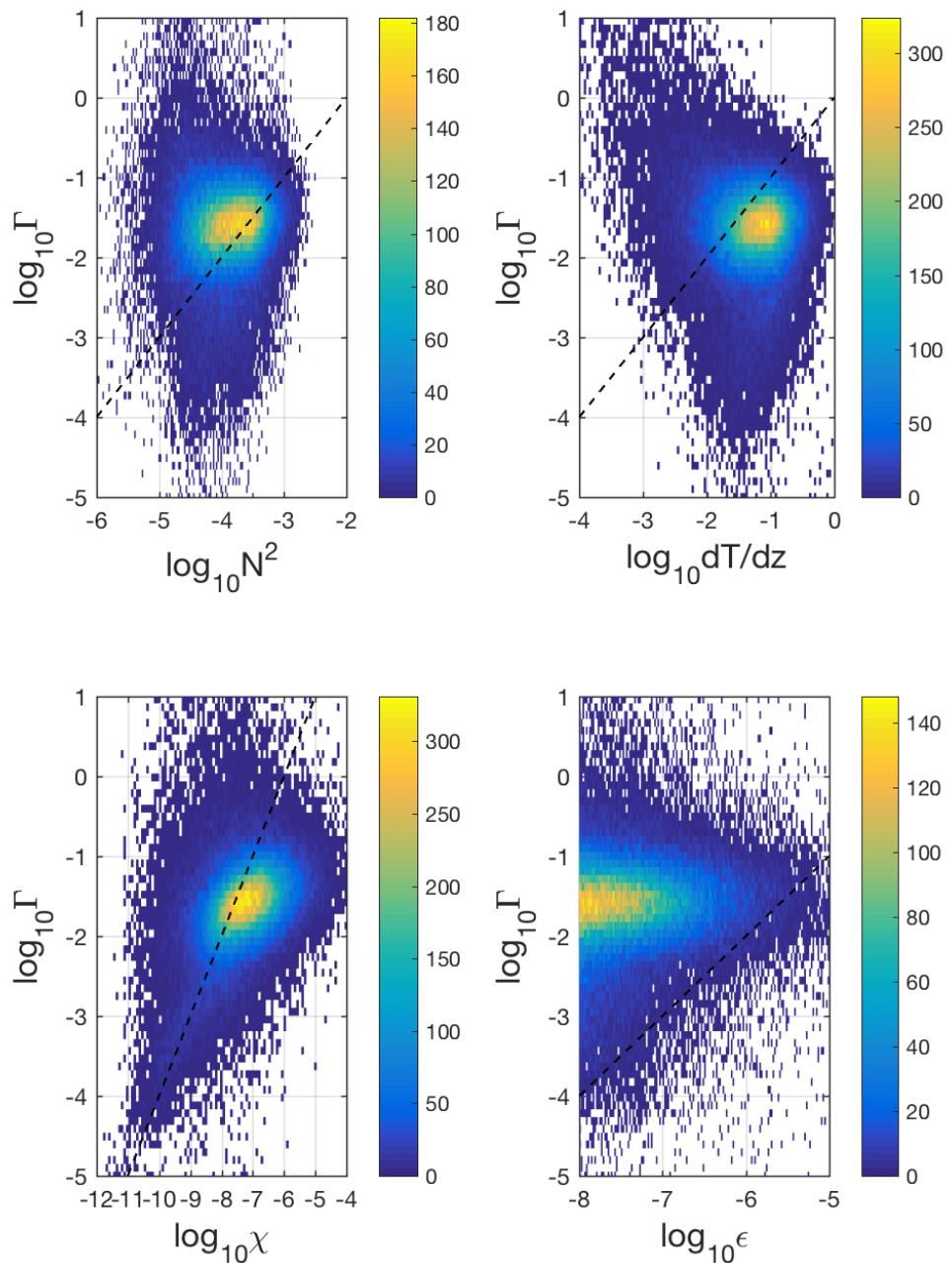


Figure 2: 2-D histograms of  $\Gamma$  vs each variable. Black line shows 1:1 relationship.

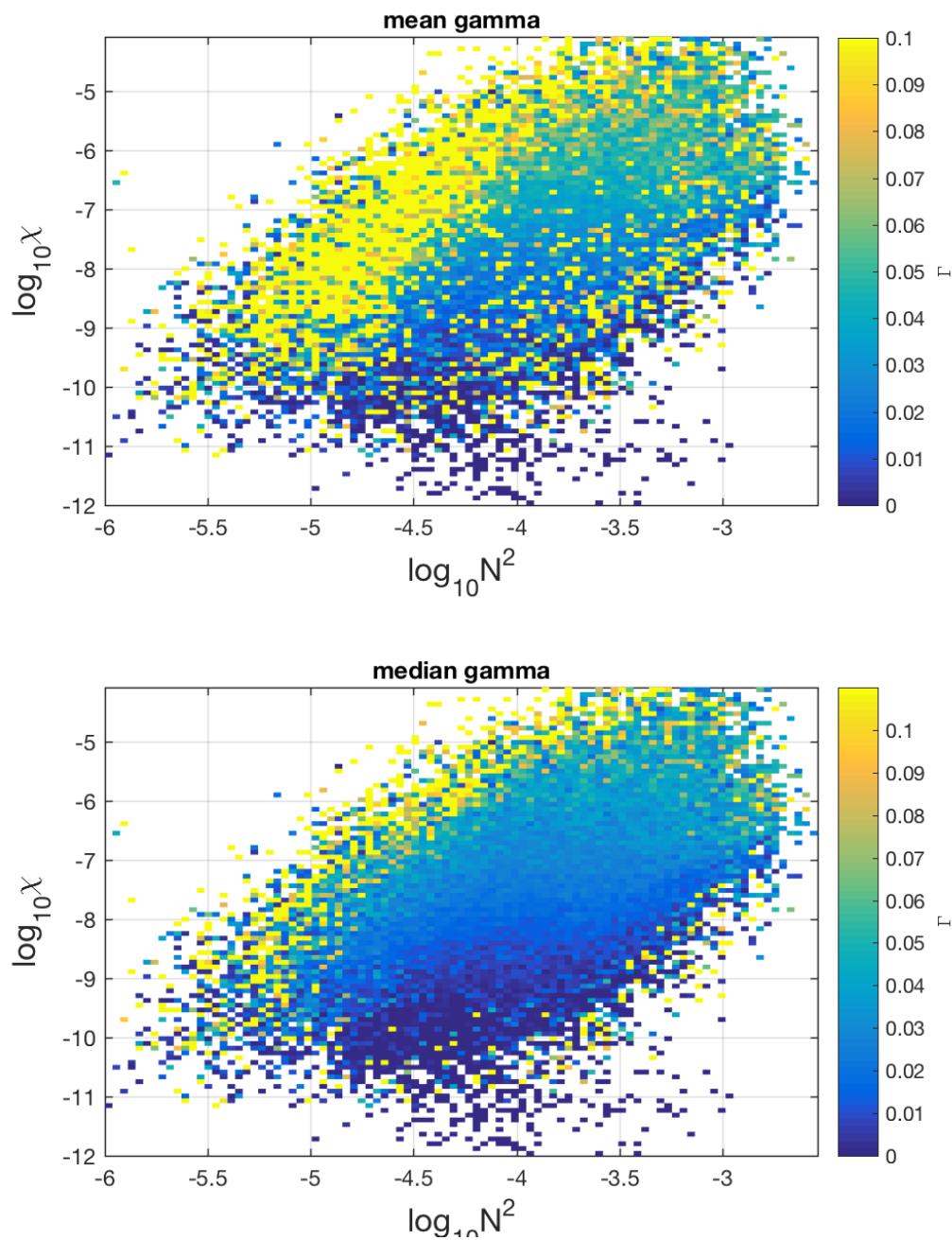


Figure 3: Mean (top) and median (bottom) values of gamma computed for bins of  $\chi$  and  $N^2$ .

### 3 Identifying Patches

I first identify patches (overturbs) using potential density computed from 1m binned temperature and salinity from Chameleon profiles. This is done w/ `IdentifyPatches.m`.

- Figure 4 shows the distribution of patch sizes from all profiles (excluding those above 20m and below 180m). Only about 11% of the original patches are in this good depth range. Most of the patches are very small (1-2m).
- Figure 5 shows  $\epsilon$  with overturn locations plotted over. The majority of the identified overturns occur between 20-60m, associated with the diurnal cycle of turbulence. These probably shouldn't even be included in the chipod analysis since the assumed dynamics do not hold.
- Below that, overturns generally co-occur with larger  $\epsilon$  measured by chameleon shear probe. There are some that occur where chameleon  $\epsilon$  is small, however.
- Figure 6 shows distributions of all data versus just data within the identified patches. Patches are associated with lower  $N^2$  and  $dtdz$ , and higher epsilon. The distribution of chi does not appear to be significantly different.

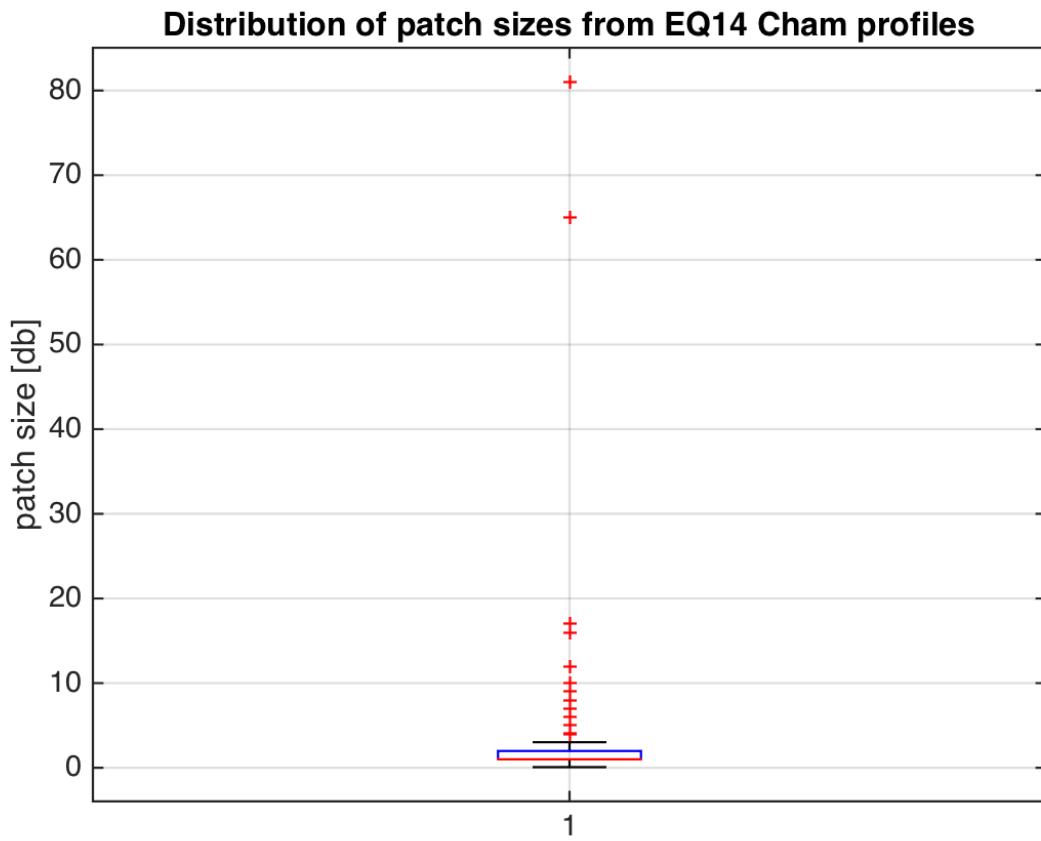


Figure 4: Boxplot of the patch sizes for all EQ14 chameleon profiles. Only patches occurring at depths between 20 and 180 m are considered.

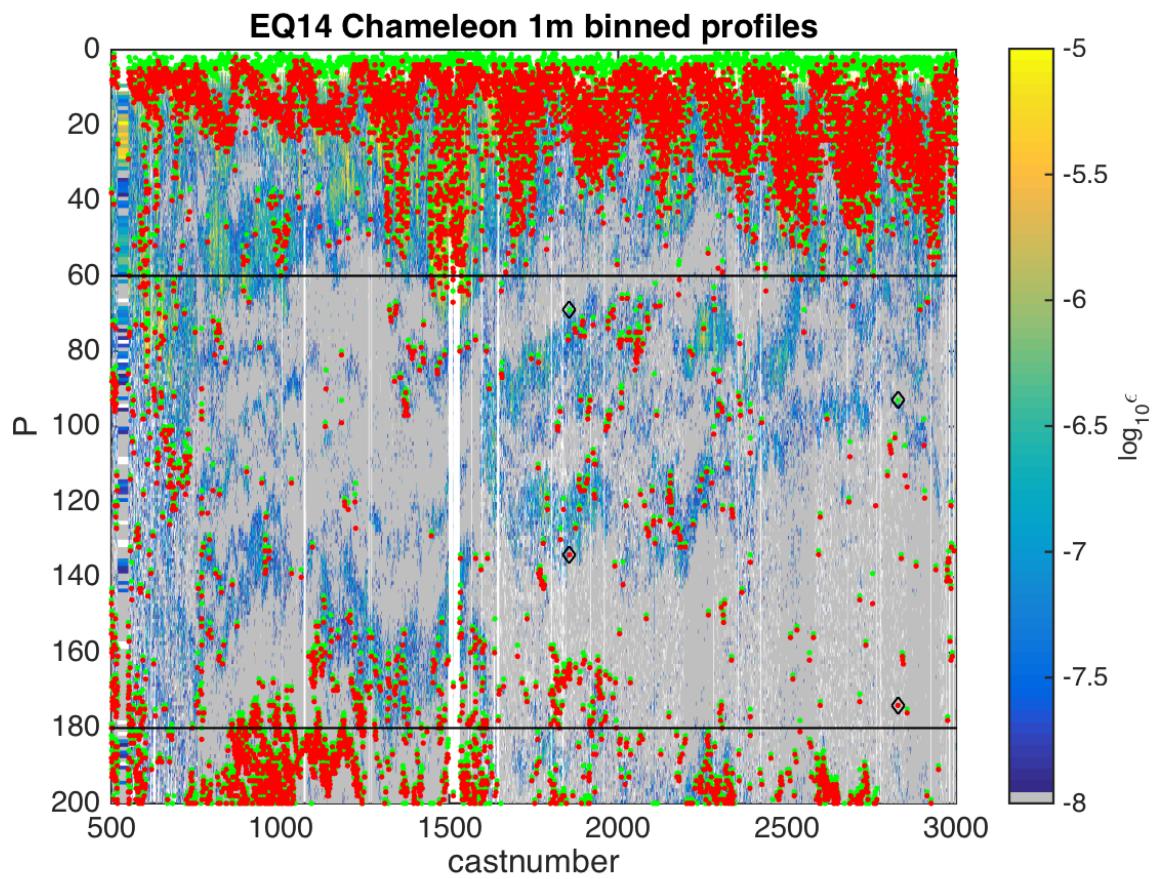


Figure 5:  $\epsilon$  measured by chameleon shear probes on EQ14 profiles. Identified overturns are plotted in green/red. Black diamonds indicate overturns larger than 20m, these are ignored (there are only 2).

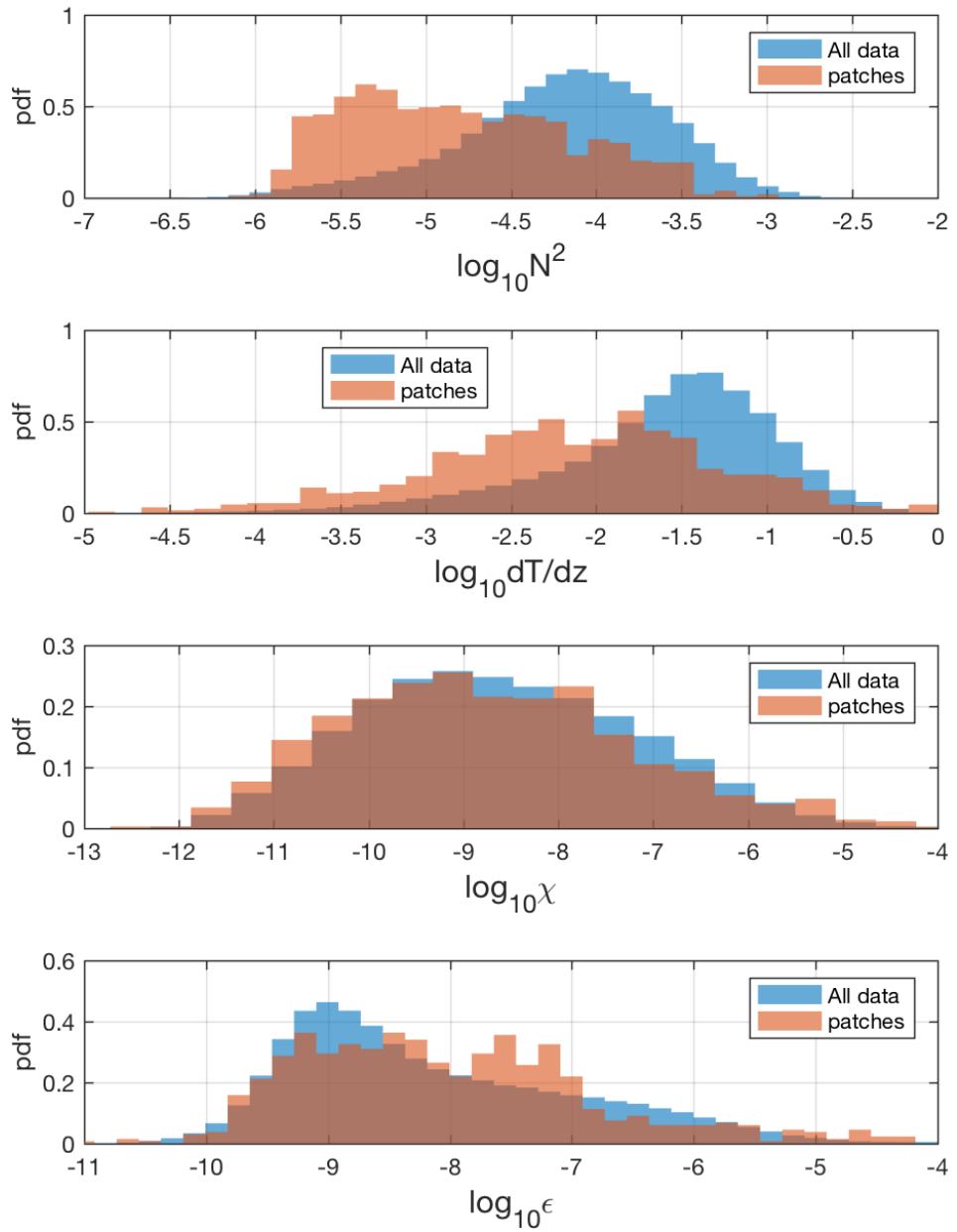


Figure 6: Distributions of  $N^2$ ,  $dT/dz$ ,  $\chi$ ,  $\epsilon$  from EQ14 chameleon profiles, for all data and just within patches.

## 4 Computing gamma by patch

The next step is to compute  $\Gamma$  over each patch. I will use  $N^2$  and  $dT/dz$  averaged over the patch (since most patches are very small, this probably won't differ too much?). For  $\chi$  and  $\epsilon$ , I should compute these from spectra over the entire patch. This will involve hacking into the chameleon processing codes a bit... Before I do this, I will try just using the 1m binned values within each patch.

So far this doesn't seem to be giving me anything close to  $\Gamma = 0.2$  (figure 7). Figure 8 shows gamma plotted vs patch size. It seems like the maximum gamma decreases linearly with patch size. We can also see that gamma is dominated by a very large number of small values, especially for smaller patch sizes.

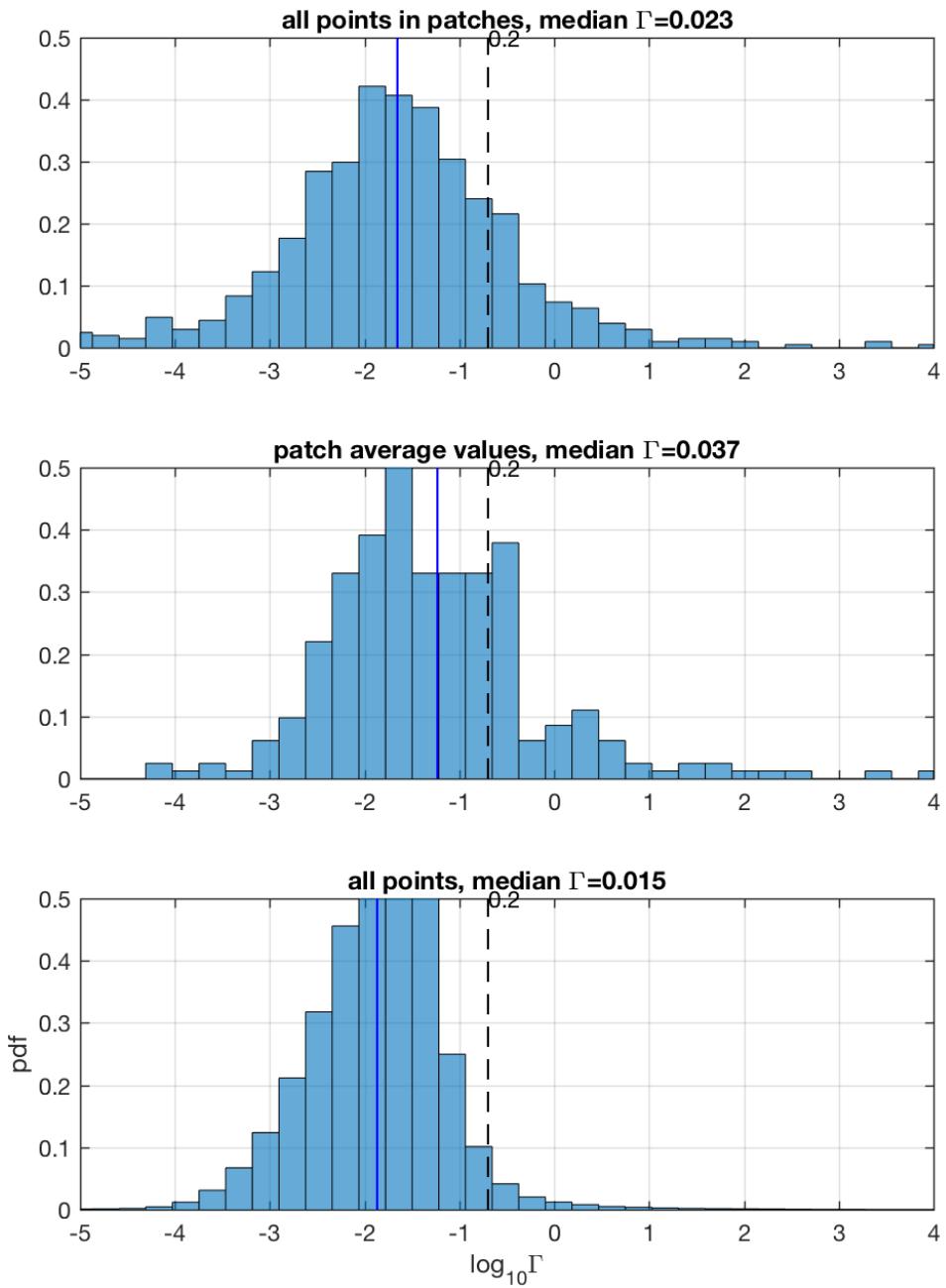


Figure 7: Histograms of gamma for (1) all points within patches (2) using averaged values from patches (3) using all points. Only data between 60-180m depth is used for all. Blue line shows median of each distribution, and black dashed line is 0.2.

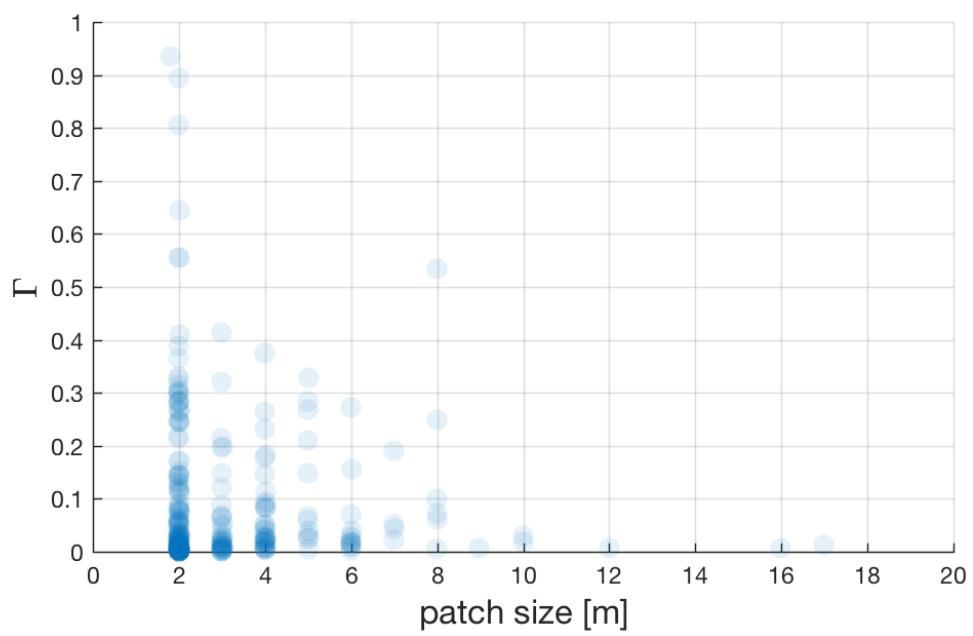


Figure 8: Scatter plot of gamma vs patch size for EQ14 profiles.

## 5 TIWE Patches from Bill

See `LookAt_TIWE_Data_Bill.m`. Bill sent data from TIWE patches (patches computed by Doug Caldwell?), I saved them in `/ChiPod/TIWE/events_TIWE.mat/`.

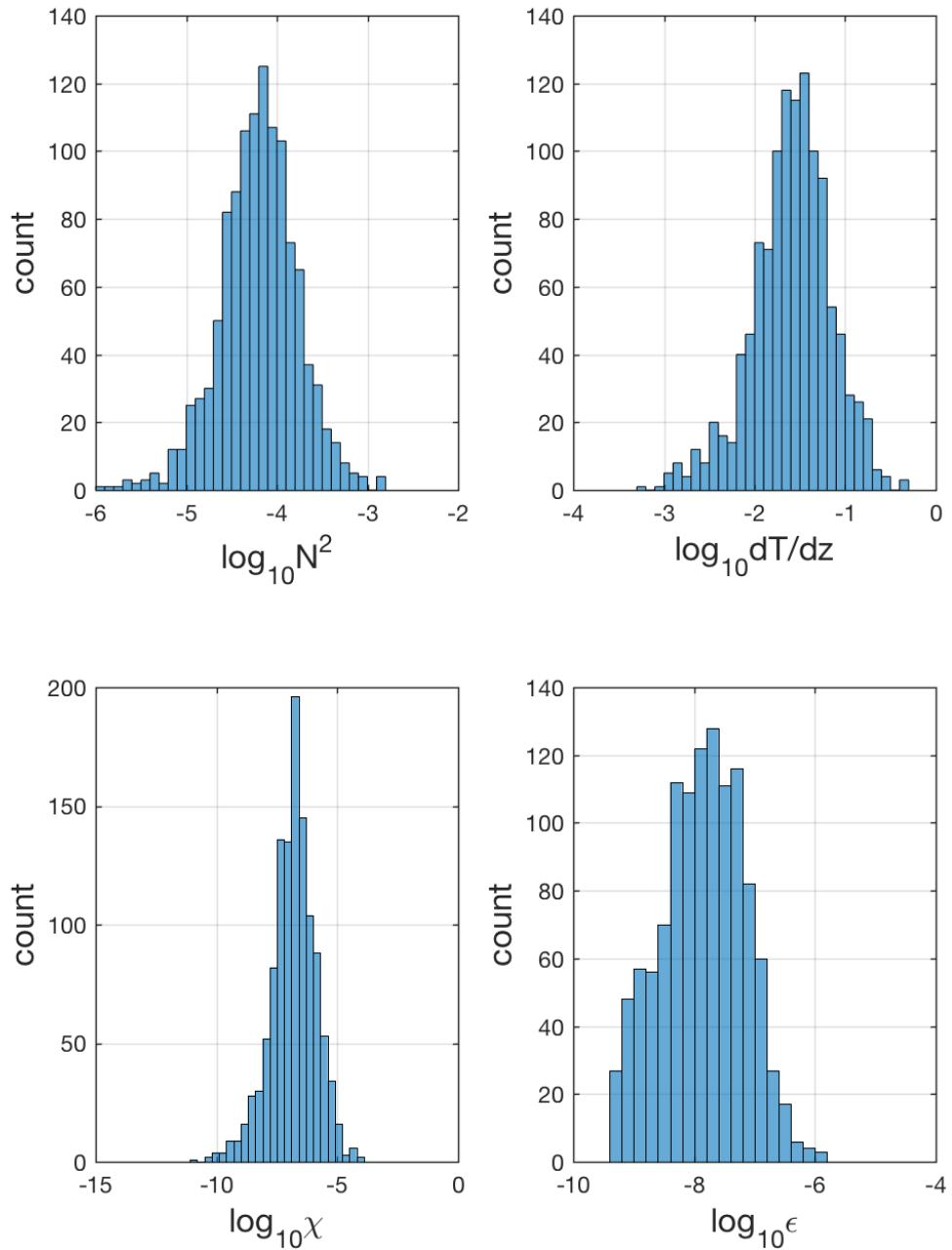


Figure 9: Histograms of data from Bill's tiwe patches.

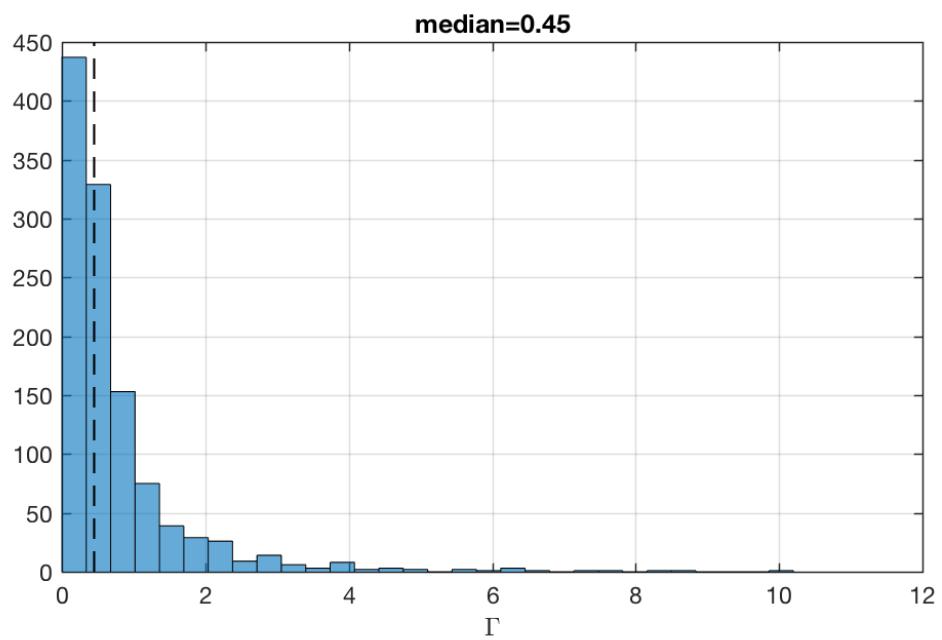


Figure 10: Histograms of gamma computed w/ data from Bill's tiwe patches.

## 6 FLX91 Patches

Jim and Bill both sent their patch data from flx91 also. I saved these as  
ChiPod/Flux91/flx91\_patch\_out\_nov94.mat and  
ChiPod/Flux91/events\_FLX91.mat.

See LookAtFlux91Data\_Jim.m, LookAtFlux91Data\_Bill.m, Compare\_tewe\_patches\_jim\_bill.m.

Summary:

- Distributions of n2, dtdz, chi, eps look a little different. Jim's data seem to contain larger values of all variables.
- But distributions of gamma look similar. Both have medians around 0.3 .
- The data is very old and codes used to compute patches not available, so it is difficult for me to reproduce the analysis or apply my own analysis to the raw data and compare.

### 6.1 Jim

### 6.2 Bill

### 6.3 Comparison

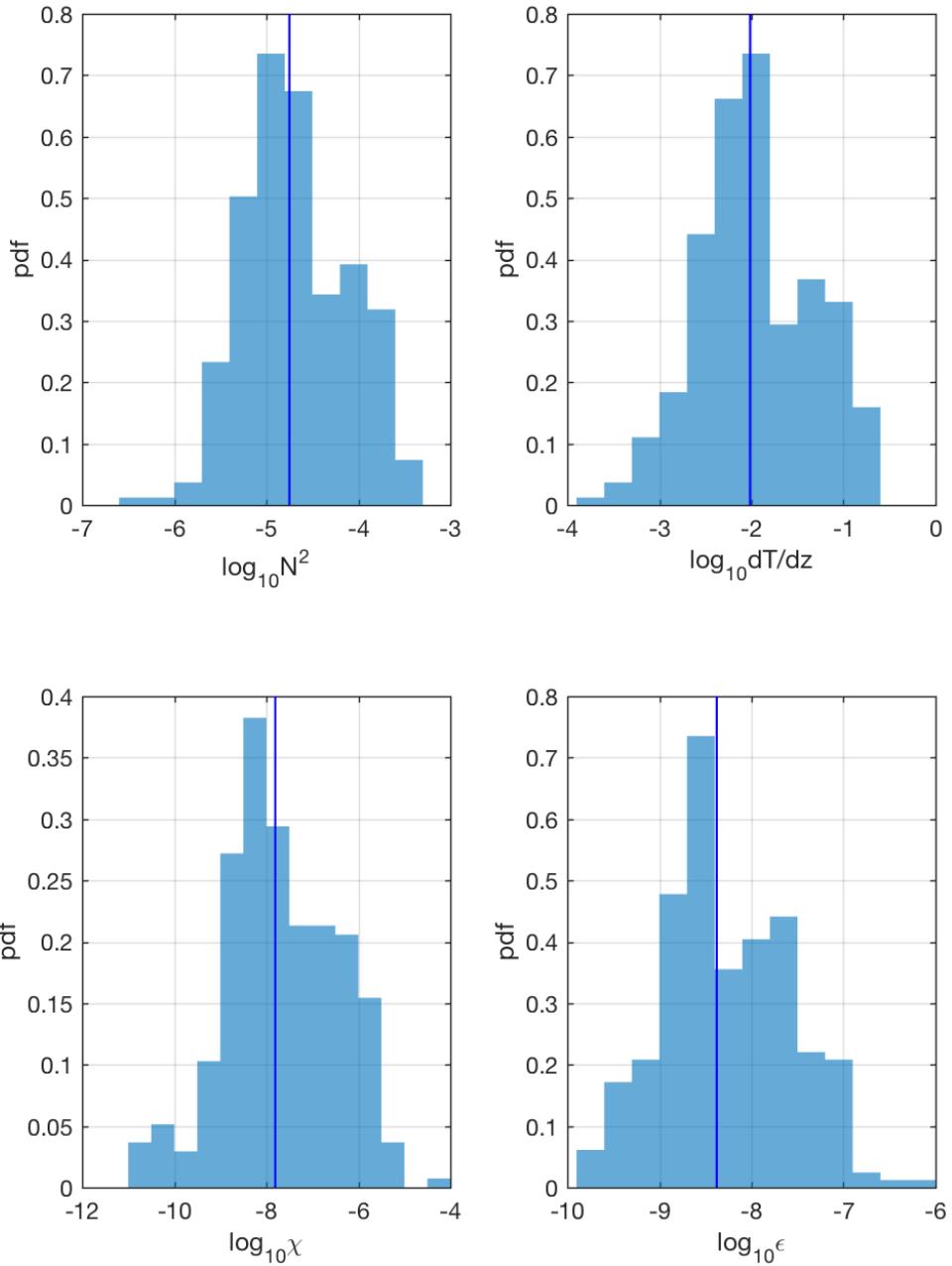


Figure 11: Histograms of data from Jim's flx91 patches. Vertical lines show median.

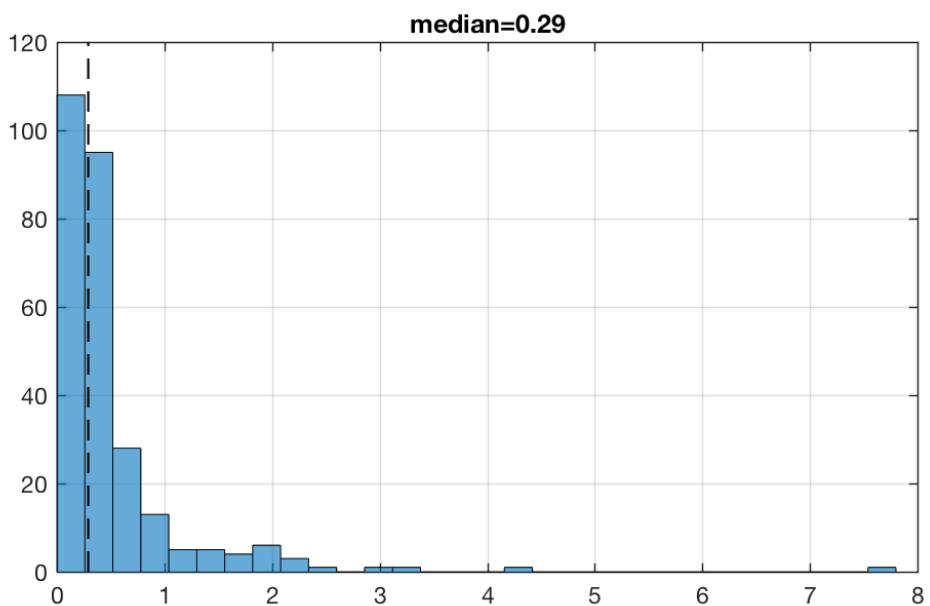


Figure 12: Histograms of gamma computed w/ data from Jim's flx91 patches.

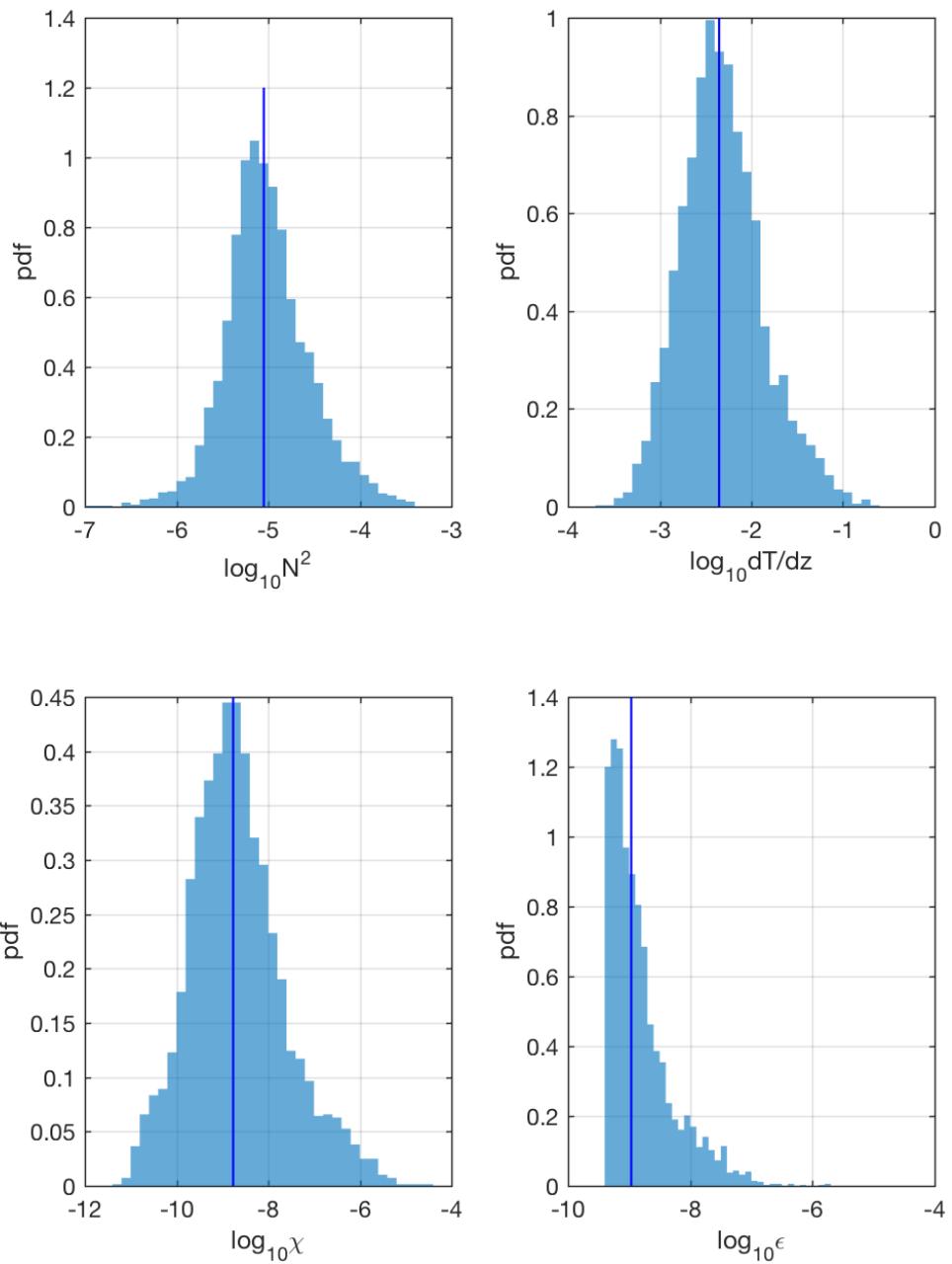


Figure 13: Histograms of data from Bill's flx91 patches. Vertical lines show median.

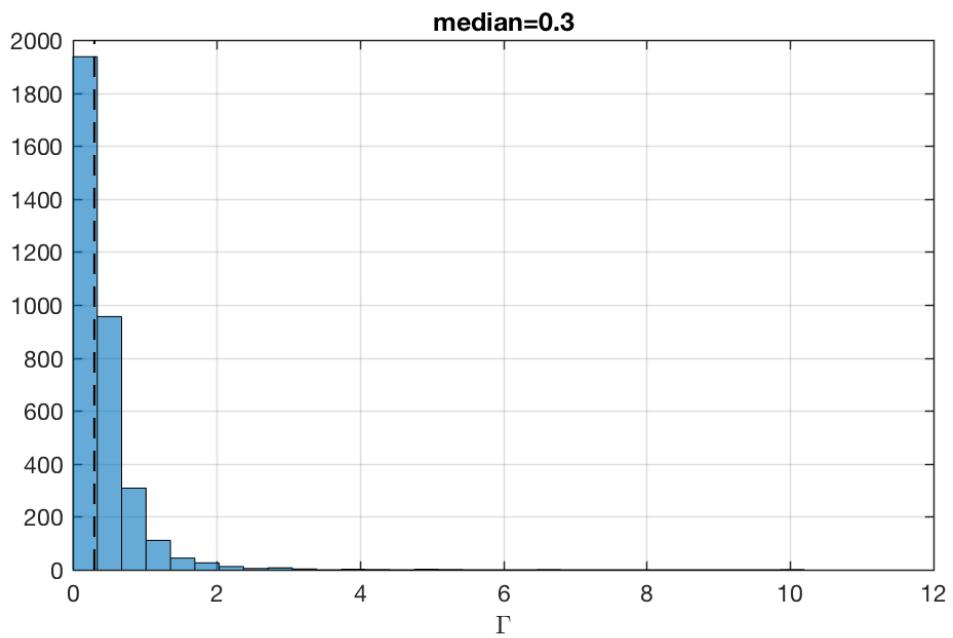


Figure 14: Histograms of gamma computed w/ data from Bill's flx91 patches.

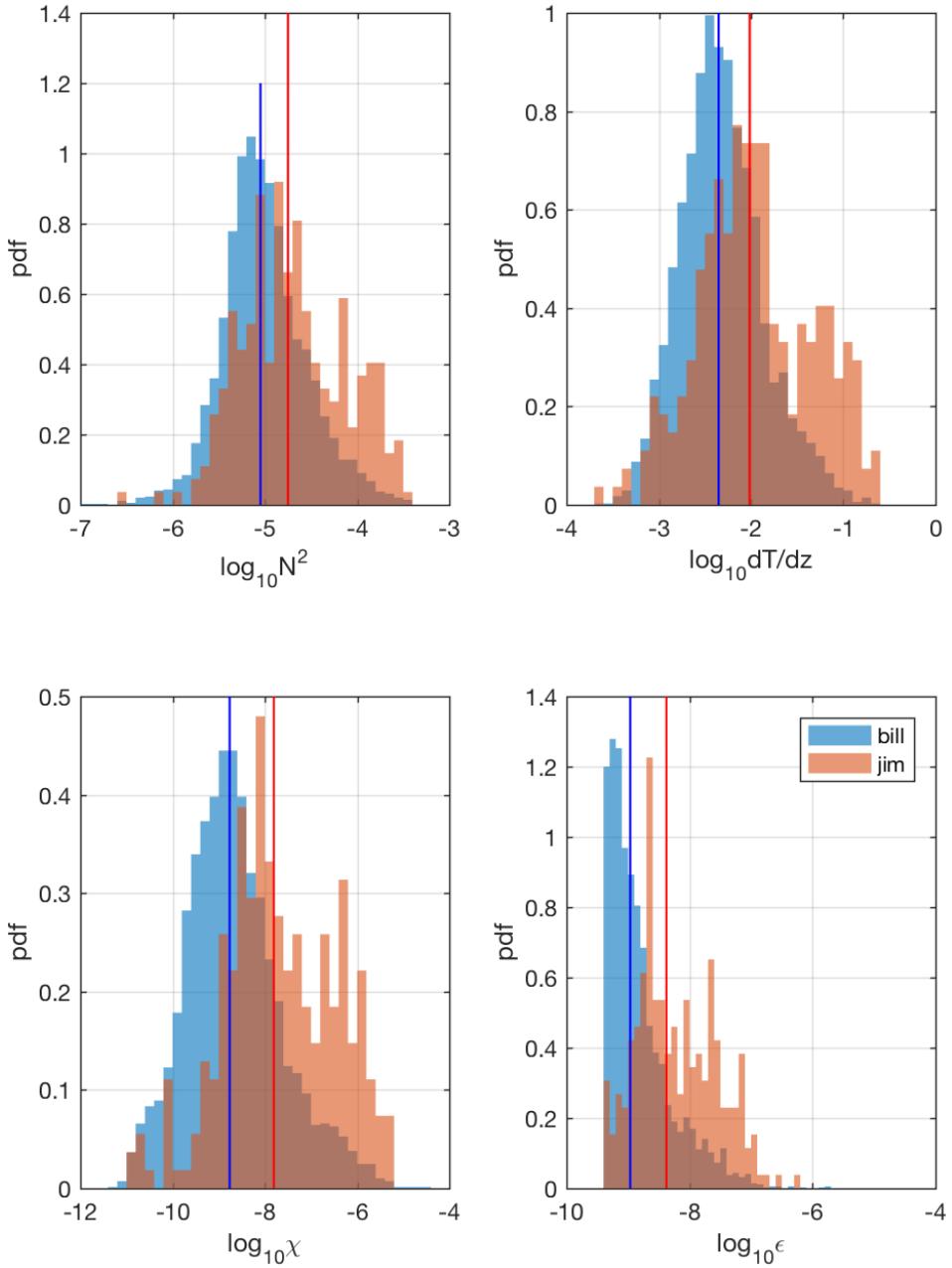


Figure 15: Histograms computed w/ data from Bill and Jim's flx91 patches.

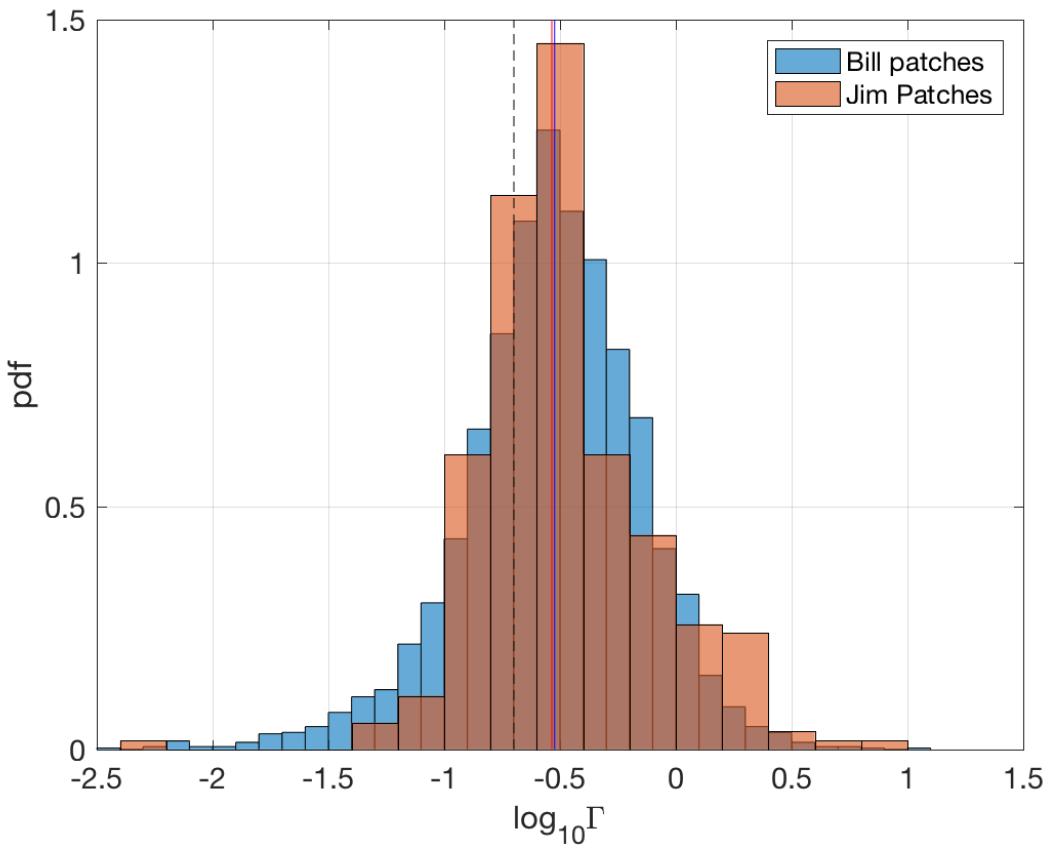


Figure 16: Histograms of gamma computed w/ data from Bill and Jim's flx91 patches.

## 7 TIWE Comparisons

Jonathan shared the entire TIWE folder (from Ganges I think?) with me on Dropbox. There are a lot of different folders/versions. Im going to try using the processed mat files for each cast in `Tiwe91/mat_Greg_analysis/`.

I first combine all the profiles in `Combine_TIWE.m`, interpolating each profile onto the same depth vector w/ 1m spacing. Figure 17 shows data from all the combined profiles. Note that something seems weird with  $dT/dz$ ; many profiles have a constant near-zero  $dTdZ$  below 150m. Other than that, the data look qualitatively similar to EQ14.

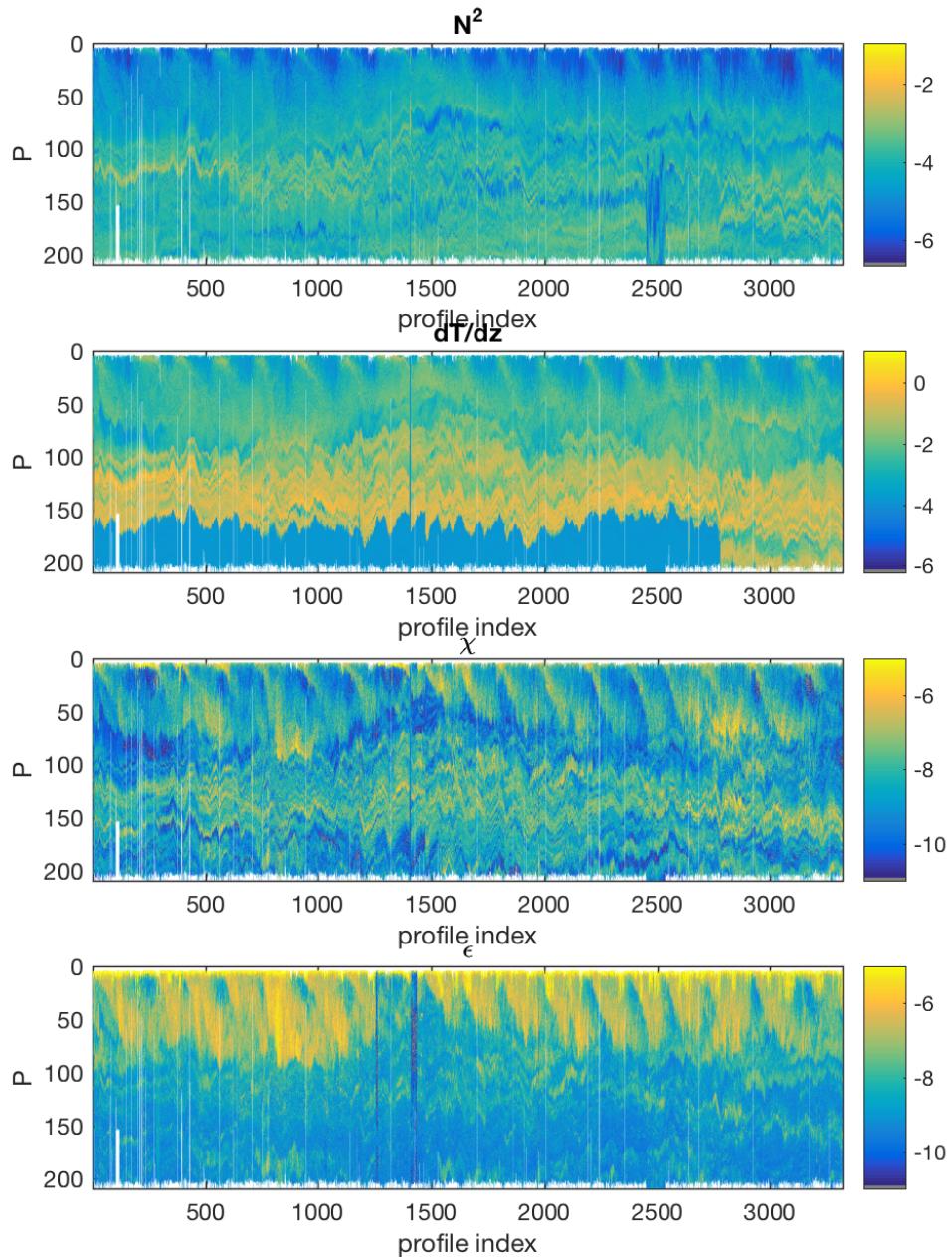


Figure 17:  $N^2, dT/dz, \chi$ , and  $\epsilon$  from combined TIWE data.

Next i'll compare the distributions of each variable to the EQ14 data (Figure 18). N2 and epsilon look very similar. Chi from tiwe is a bit narrower but they have similar medians. Dt/dz from tiwe has a spike at those weird small values, and then a sort of two-peak distribution. Figure 19 shows the same plots with the bad dtdz values removed.L

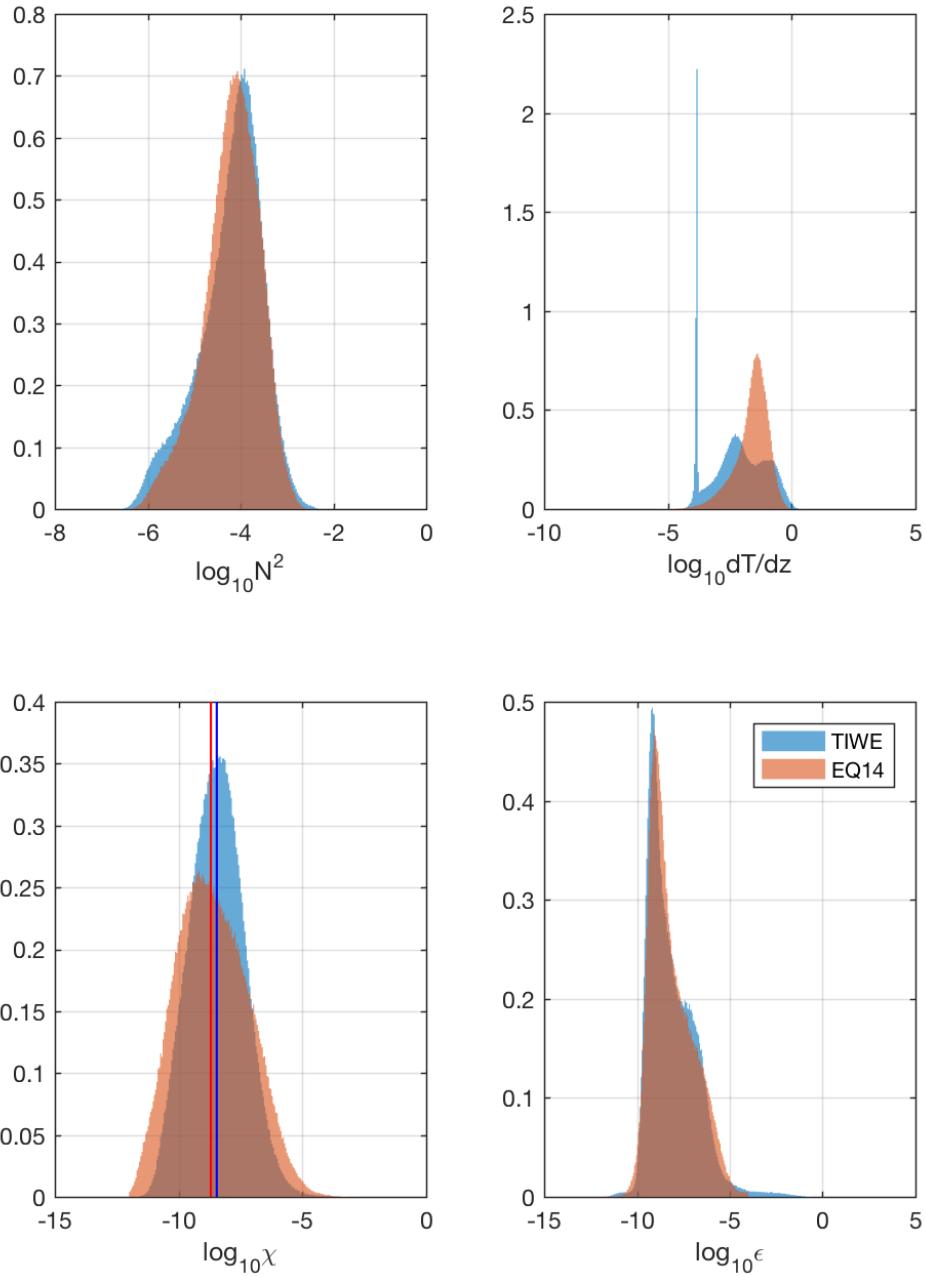


Figure 18: Histograms of  $N^2$ ,  $dT/dz$ ,  $\chi$ , and  $\epsilon$  from combined TIWE data and EQ14 data.

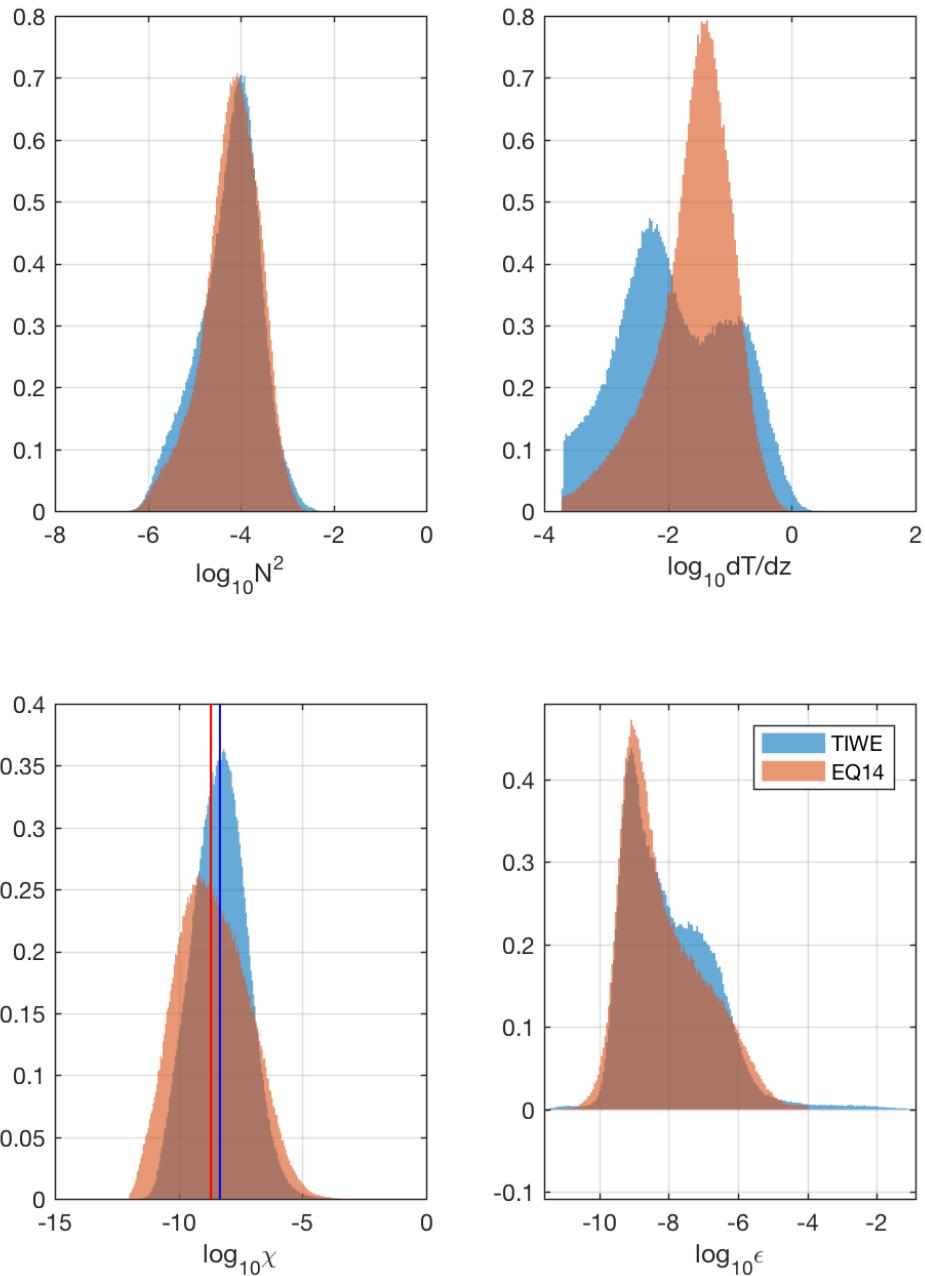


Figure 19: Histograms of  $N^2$ ,  $dT/dz$ ,  $\chi$ , and  $\epsilon$  from combined TIWE data and EQ14 data, with bad  $dT/dz$  values not included.

## 7.1 Gamma

What does gamma look like for the tiwe data? Figure 20. Gamma from tiwe is larger than eq14, with a median of about 0.06 , compared to 0.02 .

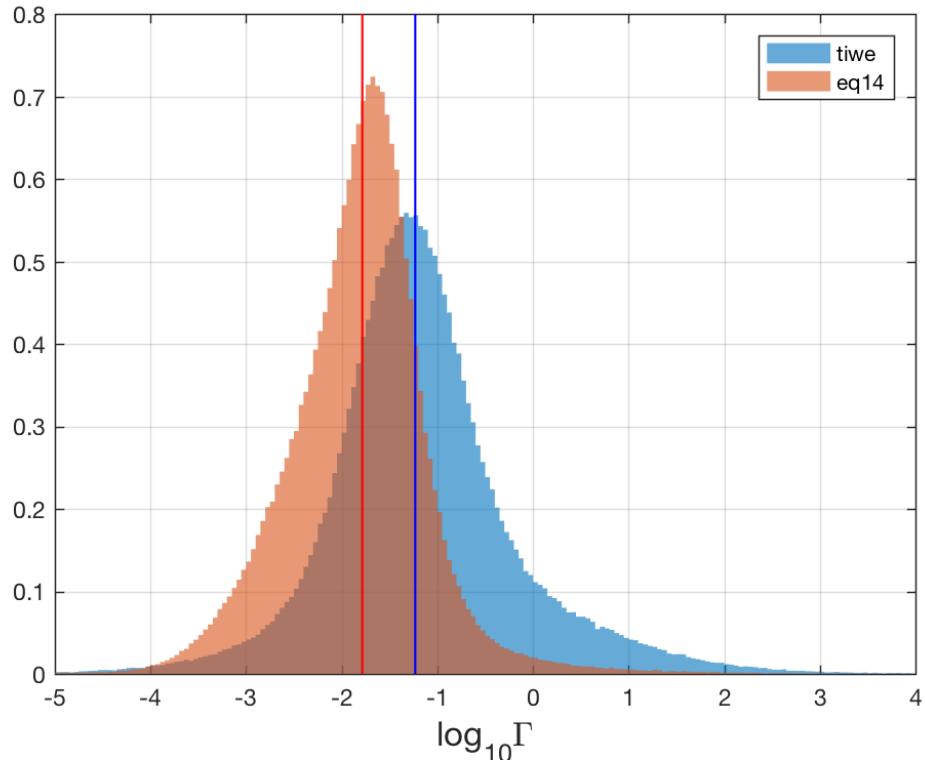


Figure 20: Histograms of gamma computed from combined TIWE data and EQ14 data (all data, not just patches).

## 7.2 Patches

Next I identify patches the same way in the tiwe data in `Find_patches_TIWE_cham.m`.

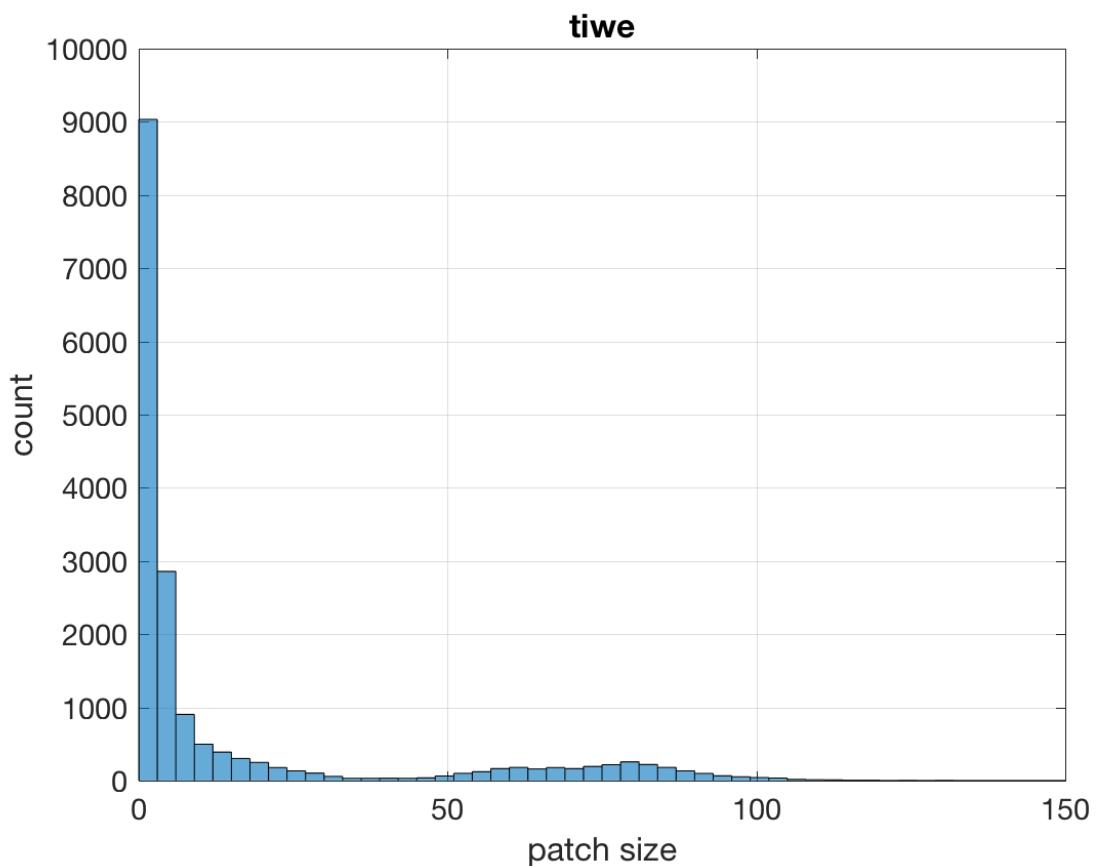


Figure 21: Histograms of patch sizes from combined TIWE.

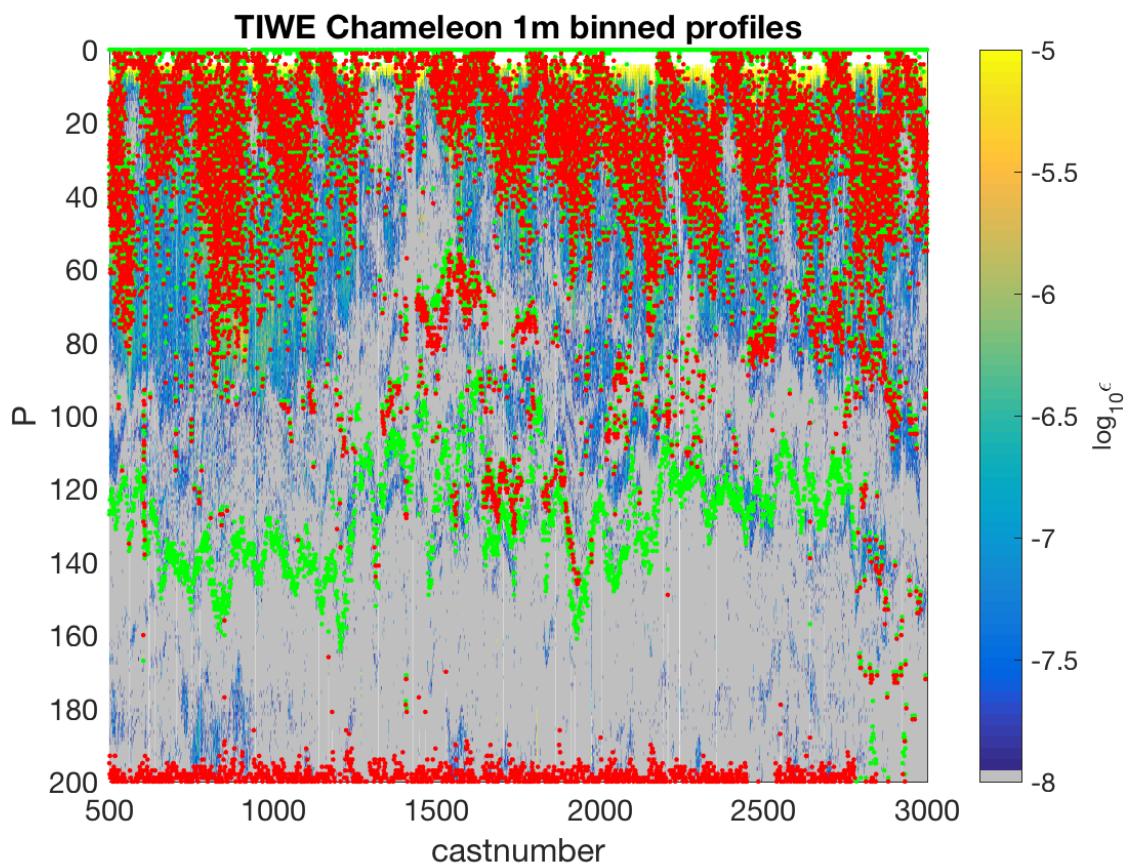


Figure 22: patches from combined TIWE.

Most of the really big patches are down below 150m where  $dtDz$  is weird. I'll exclude that data, and the surface mixed layer also.

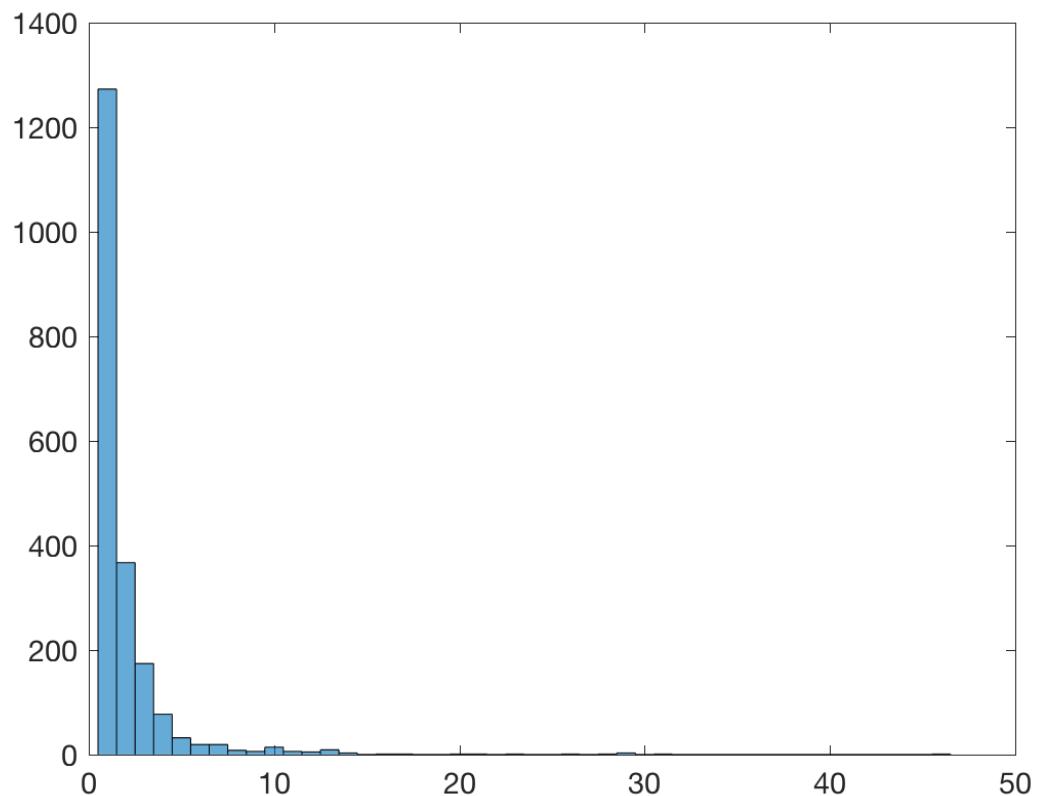


Figure 23: Histograms of patch sizes from combined TIWE.

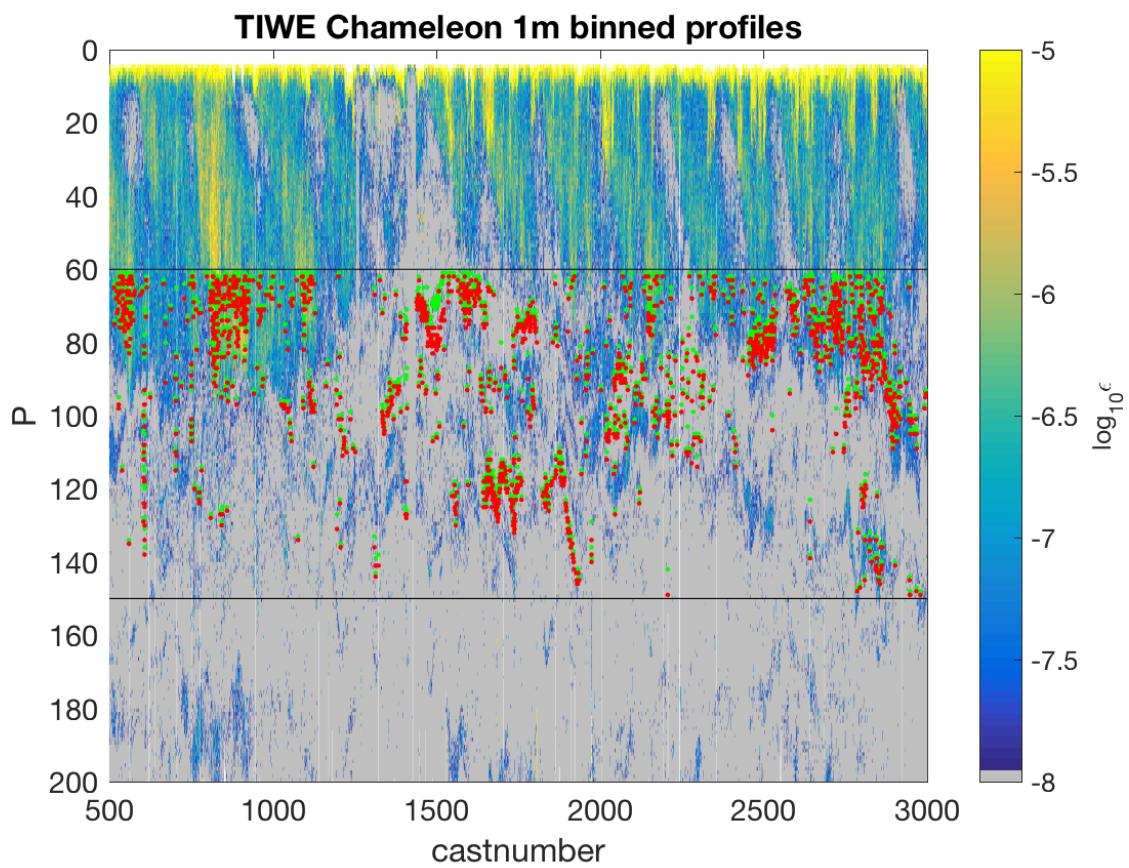


Figure 24: patches from combined TIWE.

### 7.3 Gamma in patches

Ok, first what does gamma look like if just use data within or near these patches?

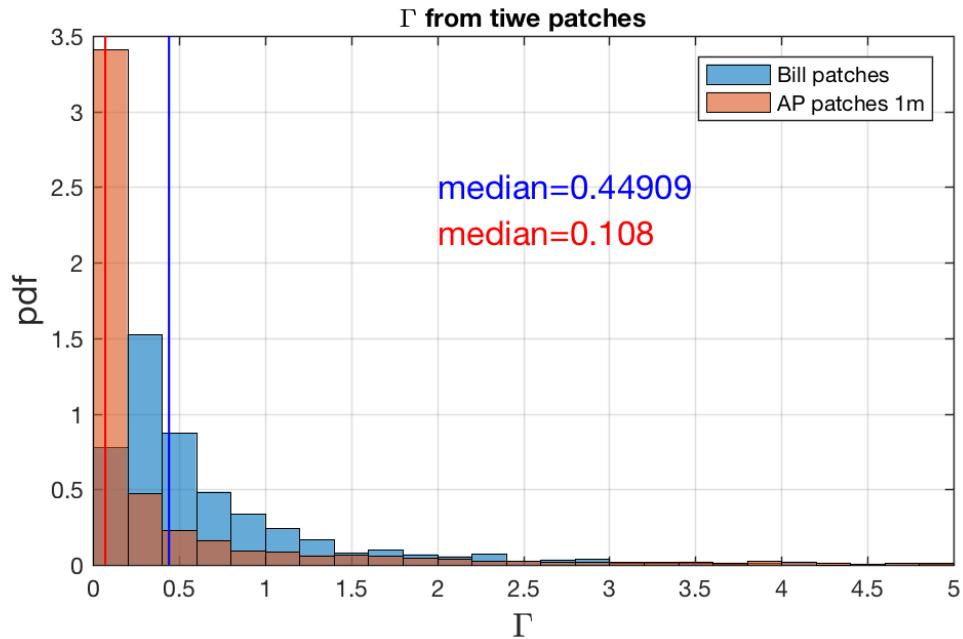


Figure 25: Gamma computed from tiwe patch data. My patches are from the 1m-binned profile data.

## 8 Identifying Patches from raw chameleon data

My approach to doing this:

- Find patches `FindPatches_EQ14_Raw.m`; this gives us the start and stop pressures for each patch in each profile, identified from the raw chameleon profiles of temp.
- Next I want to compute  $N^2, dT/dz, \chi, \epsilon$  over just these patches, instead of the usual evenly-spaced 1m bins (this is done in `average_data_gen1.m`, which is called by a script like `run_eq14.m`).
- I am making a modified version of `average_data_gen1.m` that takes the start/stop pressure of each bin as input instead of just making evenly spaced bins. My version is called `average_data_PATCH_AP.m`. I also modified it to compute  $N^2$  and  $dT/dz$  over each patch, instead of for 1m binned data as it did before. I'm just using 'bulk' gradients ie  $dT/dz = \max(T) - \min(T)/dz$  for each patch.
- So I will run a modified version of `run_eq14.m` called `run_eq14_AP.m` that loads the raw data, then calls `average_data_PATCH_AP.m`, which will return an 'avg' structure with data computed for each patch.

### 8.1 Issues

- Many choices/parameters in choosing patches: Minimum OT size, noise criteria, density vs temp, do we join nearby patches?
- How to compute  $N^2$  and  $dT/dz$ . The OT code averages  $N^2$  from the profile over the overturn region. In `average_data_PATCH_AP.m` I compute a 'bulk'  $N^2$  just using the maximum  $d\rho/dz$  over the overturn.

### 8.2 Results

- I computed overturns using three different minimum overturn sizes: 0.5m, 1m, and 2m.
- I compile all the resulting data and plot in `Plot_Gamma_patches_eq14_raw.m`
- The results depend on which  $N^2$  I use. Using the  $N^2$  from the OT code gives a gamma of about 0.1. Using the 'bulk'  $N^2$  gives a gamma of 0.3-0.4 . Both of these are much larger than the gamma I get using the averaged chameleon data for all points (0.01).

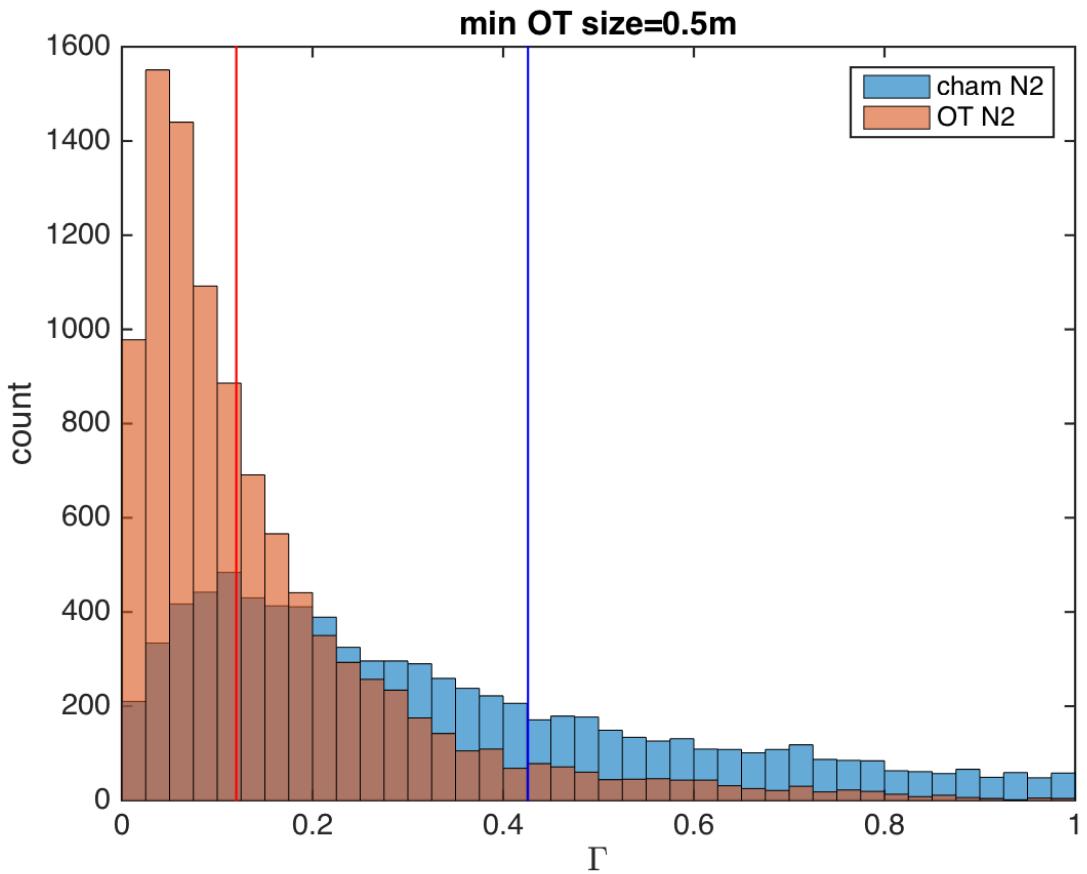


Figure 26: Gamma computed over patches from raw eq14 Chameleon data.

## 9 Nov 14, 2016

Status update:

- I've managed to compute patches and patch data (N2,dtdz,chi,eps) using raw chameleon data from EQ14.
- Depending on choice of N2, I get gammas around 0.1 or 0.3-0.4, much closer to the assumed 0.2.
- What next? I don't trust the patch data that much, there are too many parameters and choices. But it does show that the value of gamma depends heavily on how we compute it.
- I can't really compare my results to Jim and Bill's data from flx91 or tiwe because I don't know how they chose/computed patches.
- How would this be applied to chi pods? Do we only compute chi where we have overturns? Does there have to be an overturn to have mixing?