Patch/Gamma Analysis for TIWE chameleon patches

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Contents

1 Overview

The goal of this analysis is to compute mixing coefficent ($\gamma_{\chi\epsilon} = \frac{N^2\chi}{2\epsilon T_z^2}$) for patches in TIWE chameleon profiles, and see if we obtain values close to $\Gamma = 0.2$.

2 Data

Data are made by the 'Chameleon' microstructure profiler near the equator during the 'TIWE' experiment. Data was shared by JN and my local copy is at:
`/Users/Andy/Dropbox/AP_Share_With_JN/date_from_jim/Tiwe91`

I'm using the raw Chameleon data files in:
`/Users/Andy/Dropbox/AP_Share_With_JN/date_from_jim/Tiwe91/cham/tw/`

All my analysis is in the main folder:
`/Users/Andy/Cruises_Research/ChiPod/TIWE`

3 Methods

- `Run_tiwe_AP.m` Runs the standard Chameleon processing, producing 1m avg quantities. I modifed this from `run_tw91.m`.
- `Combine_tiwe_avg_profiles.m` Combines the avg profiles made in `Run_tiwe_AP.m` into a single structure with common depths.
- `Process_tiwe_rawprofiles_AP.m` Processes raw Chameleon files and saves 'cal2' files which have the raw/ high-res profiles of temp and salinity. These are used to identify patches. χ and ϵ are not computed for these.
- `FindPatches_tiwe_Raw.m` Identifies patches in each profiles made by `Process_tiwe_rawprofiles_AP.m`, using potential temperature.
- `Compute_N2_dTdz_patches_tiwe_eachcast.m` Computes N^2 and T_z for patches, using several different methods. Saves results for each profile in a structure 'patches'.
- `add_binned_to_patches.m` Adds the binned (ie the standard 1m avg values) χ and ϵ to the profiles of patches at patch locations. Binned profiles are interpolated to patch depths.
- `Run_tiwe_AP_forPatches.m` Runs the Chameleon processing (including χ and ϵ) for just the patches identified in `FindPatches_tiwe_Raw.m` . This calls `average_data_PATCH_AP.m` instead of `average_data_gen1.m`.

- `add_patch_chi_eps_to_patches_tiwe_each_profile.m` adds the values of χ and ϵ from `Run_tiwe_AP_forPatches.m` to the patch profiles.
- `combine_patch_profiles.m` combines all the individual patch profiles into a single structure.

3.1 dTdz

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

1. $dtdz_{range}$: Take the range of T over the patch and divided by patch height
2. $dtdz_{line}$: Fit a straight line to sorted T using `polyfit`
3. $dtdz_{bulk}$: 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_{range} : Take the range of potential density over the patch divided by the patch height ($d\rho/dz$), then compute $N^2 = \frac{-g}{\rho_o}\frac{d\rho}{dz}$ where ρ_o is the mean potential density over the patch.
2. N^2_{line} : Fit a straight line to sorted potential density using polyfit to get $d\rho/dz$, then compute N2.
3. N^2_{bulk} : Use 'bulk gradient' . This is calculated from the bulk T_z, using a linear fit between density and temperature.
4. 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 coefficient (Efficiency)

Mixing coefficient $\gamma_{\chi\epsilon}$ 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. $\gamma_{\chi\epsilon}$ is computed for the following 4 combinations:

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

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

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

4. γ_{range} : N^2_4, $dtdz_{line}$

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

4 Results

- For some reason many χ values below 150db are bad/missing? Not sure why.
- The median $\gamma_{\chi\epsilon}$ computed using the 1m avg data is 0.063 (Figure 2).
- Gamma computed over patches w/ linear fits is slightly higher than the binned gamma, but still less than 0.2 (Figure 3).

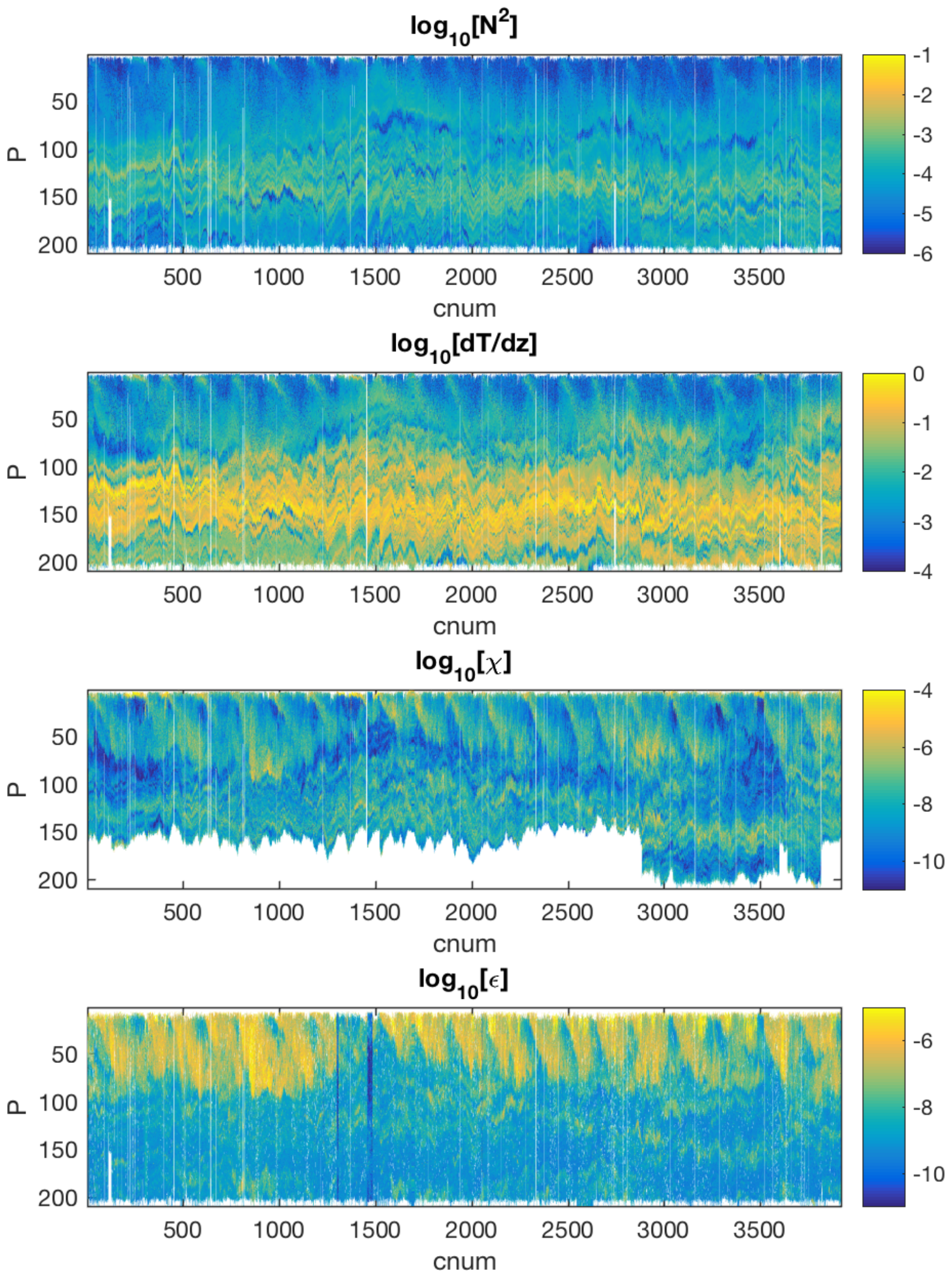

Figure 1: Pcolor of the combined 1m avg chameleon data for TIWE. * Note for some reason many χ values below 150db are bad/missing.

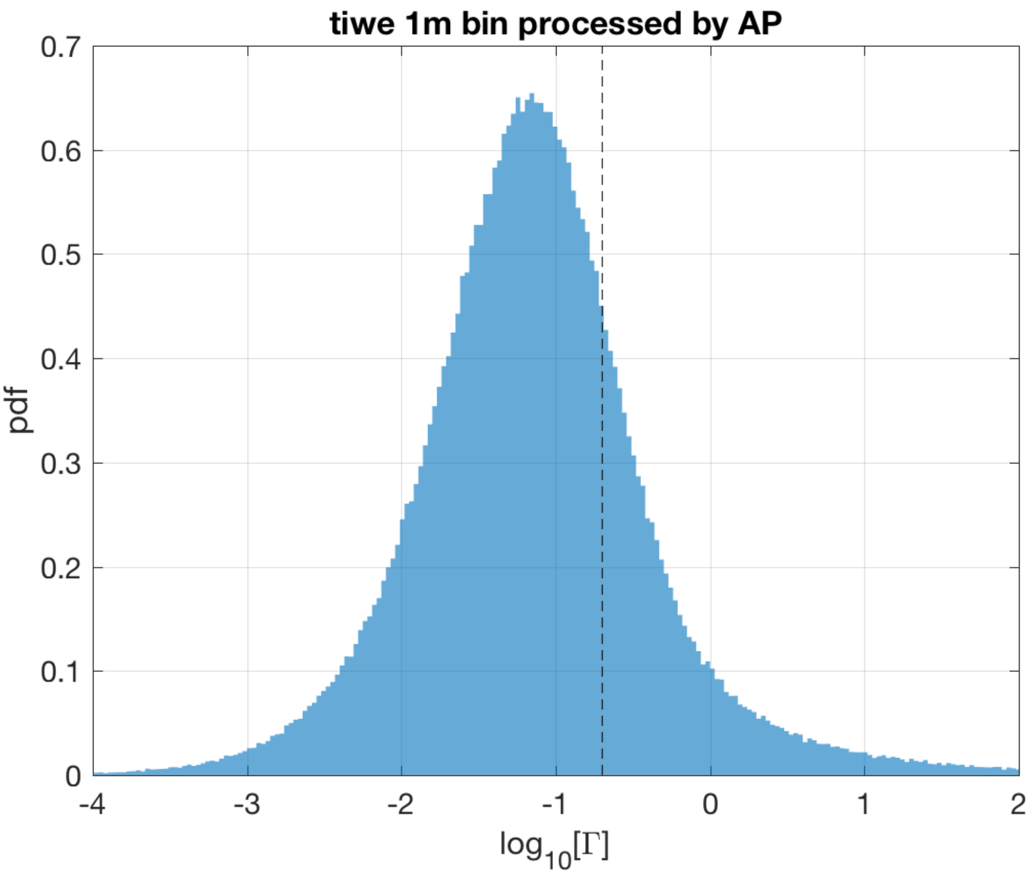

Figure 2: Histogram of $\gamma_{\chi\epsilon}$ for 1m avg chameleon profiles. Vertical dashed line shows $\gamma_{\chi\epsilon} = 0.2$.

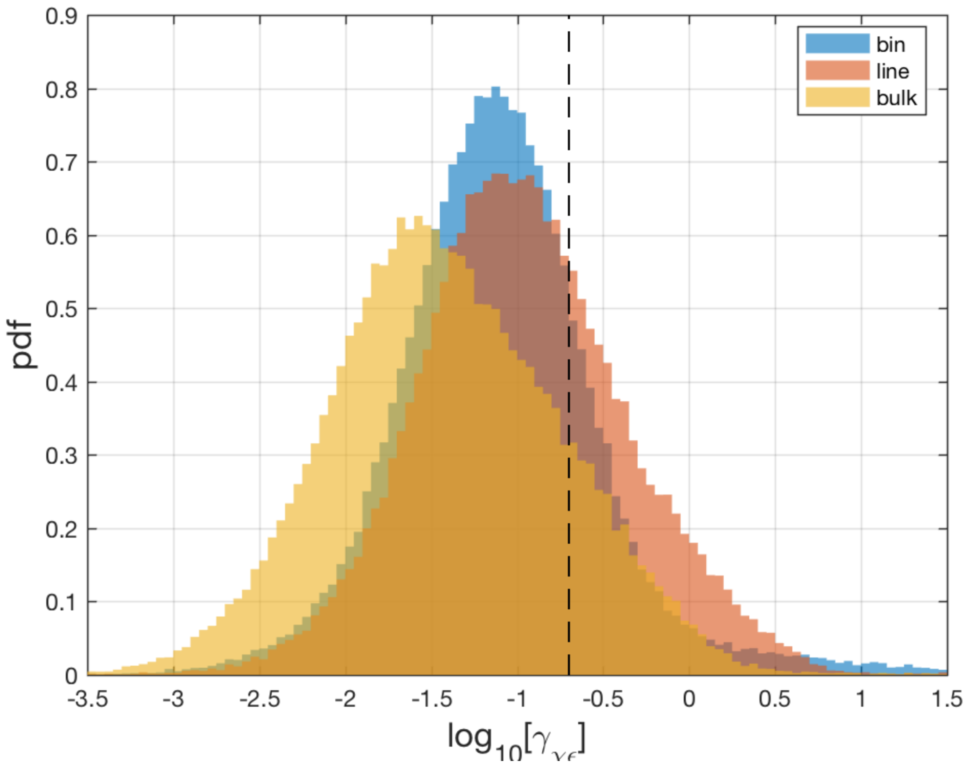

Figure 3: Histogram of $\gamma_{\chi\epsilon}$ for patches, using different estimates of N^2 and T_z. Vertical dashed line shows $\gamma_{\chi\epsilon} = 0.2$. For all profiles.

5 Comparison to previous analysis

Bill send me results of a previous patch analysis for tiwe: `events_TIWE.mat` . Here i'll compare my results to those. See `compare_patches_tiwe_AP_Bill.m` . It looks like my values of T_z, and χ tend to be significantly smaller than Bill's (Figure 4). Gamma computed from my patch values (using all profiles) is smaller than 0.2 (median 0.08), while gamma from Bill's values is larger than 0.2 (median 0.4),(Figure 5).

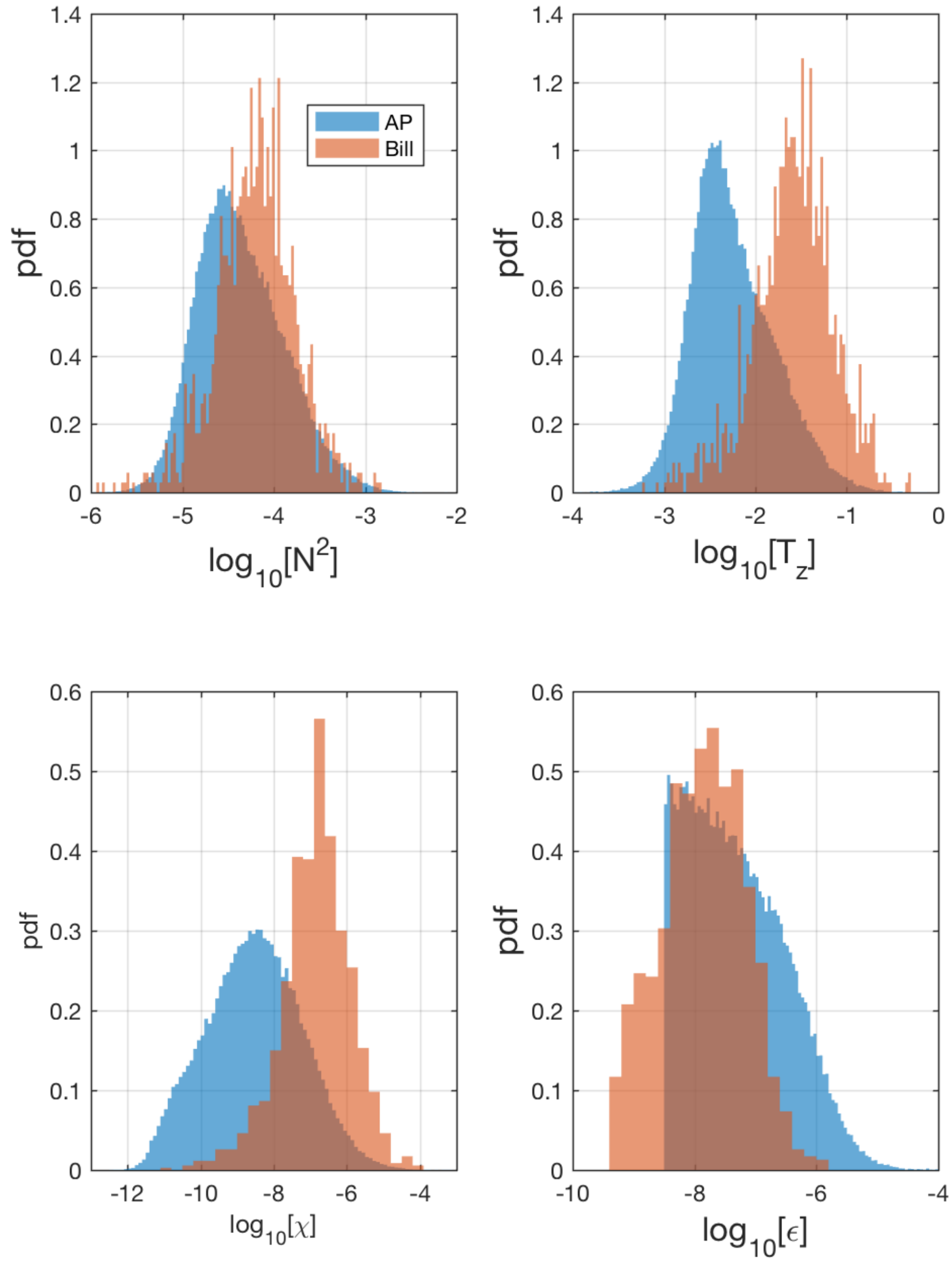

Figure 4: Histograms of N^2 , T_z, χ, and ϵ for patches analyzed by myself and Bill. Data for *all* profiles.

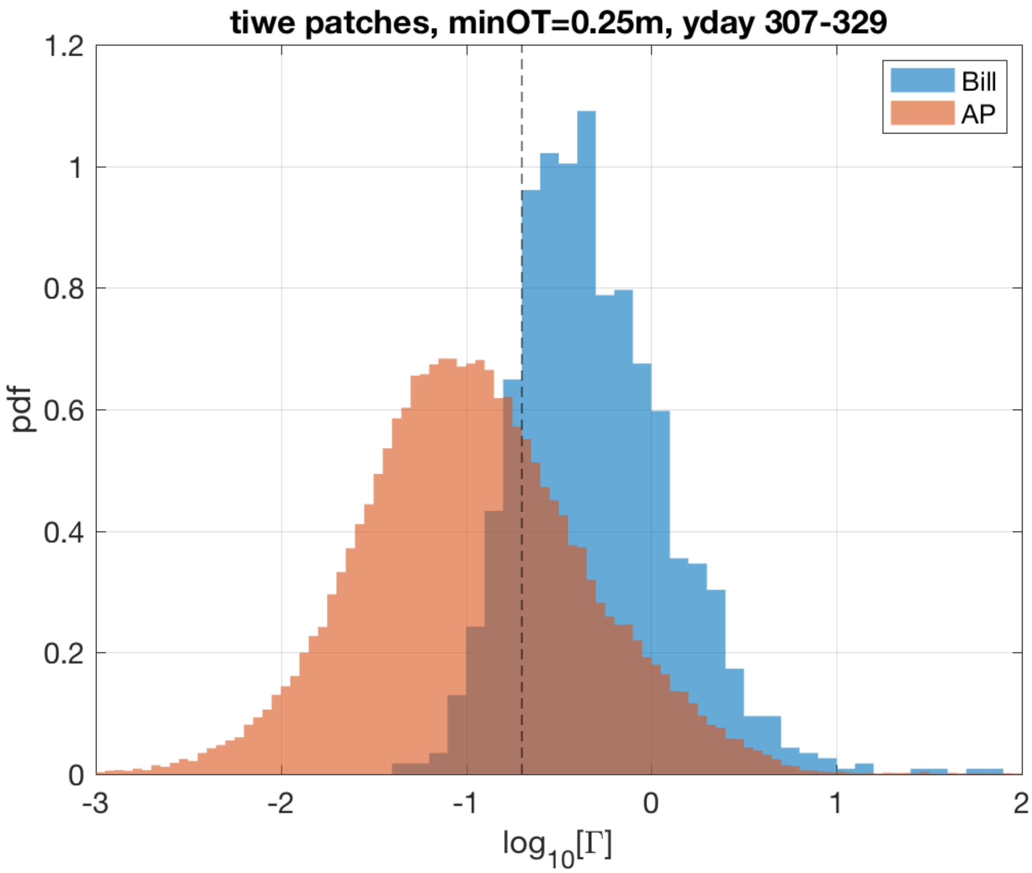

Figure 5: Histograms of $\gamma_{\chi\epsilon}$ for patches analyzed by myself and Bill. Data for *all* profiles.

5.1 Yday 324-327

I noticed that in Smyth et al 2001, only data from ydays 324-327 is used for theTIWE patches. So I remade the previous figures using only data from that time period (Figures 6,7). Using this data, I get gammas centered around 0.2 and close to Bill's estimates.

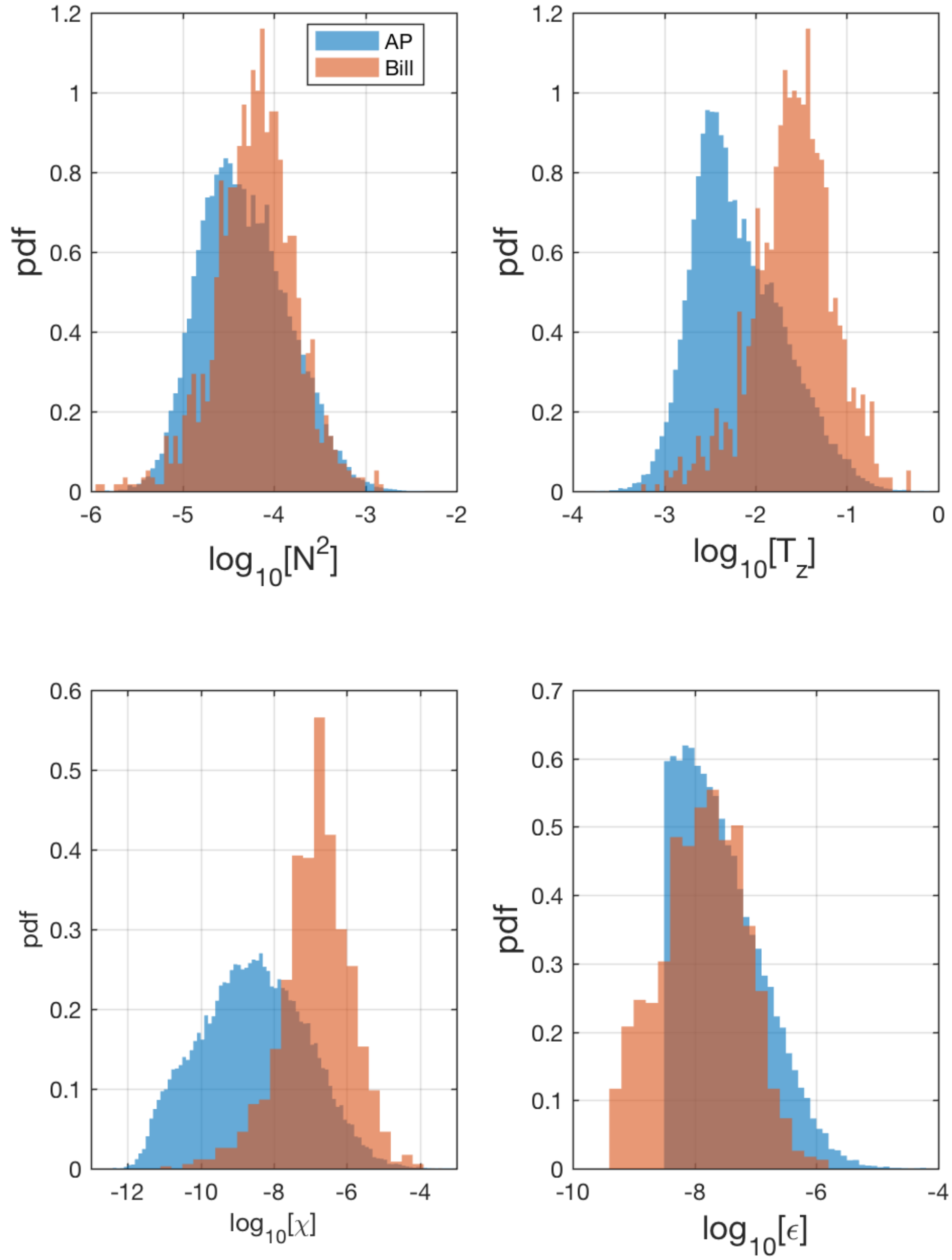

Figure 6: Histograms of N^2 , T_z, χ, and ϵ for patches analyzed by myself and Bill. Data for profiles on yday 324-327 (corresponding to data used in Smyth et al).

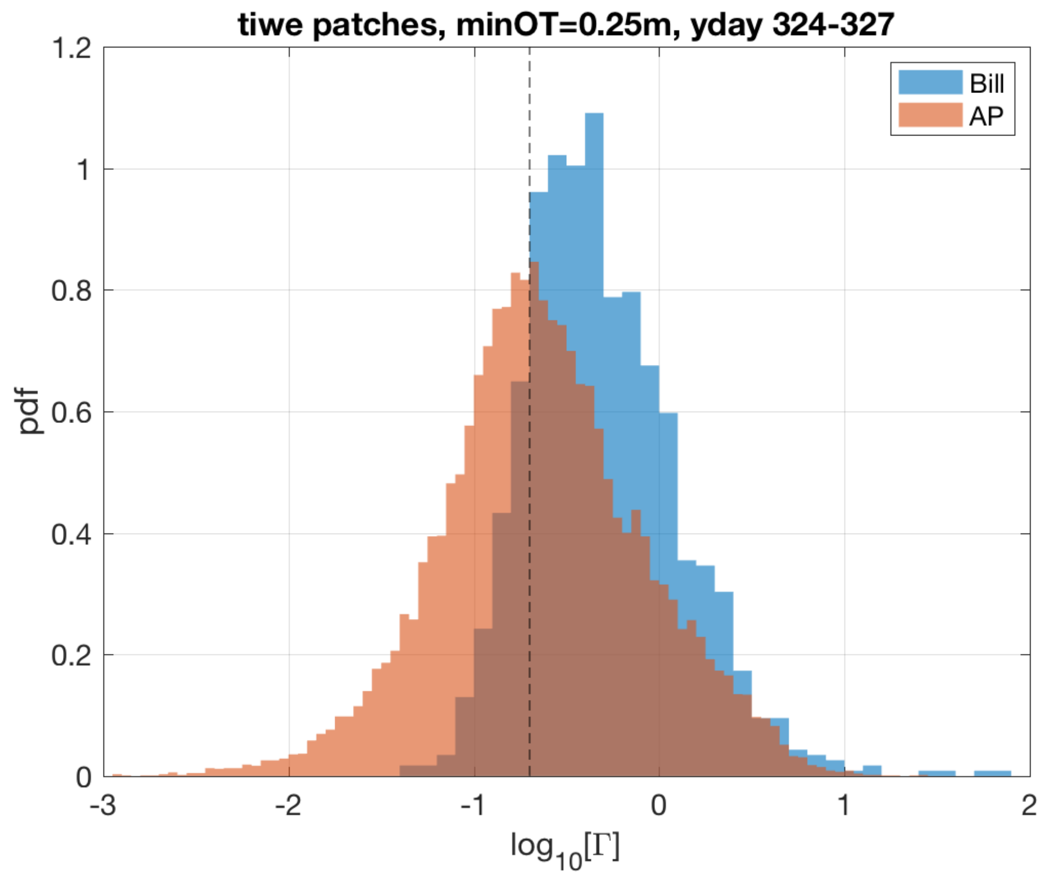

Figure 7: Histograms of $\gamma_{\chi\epsilon}$ for patches analyzed by myself and Bill. Data for profiles on yday 324-327 (corresponding to data used in Smyth et al).

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

Since it appears that $\gamma_{\chi\epsilon}$ can vary for different time periods, I wanted to investigate this more. I plotted $\gamma_{\chi\epsilon}$ vs yday (Figure 8). It looks like the median $\gamma_{\chi\epsilon}$ is smaller than 0.2 for ydays less than 315, and then about equal to 0.2 after that (a few days are abnormal and might not have many profiles).

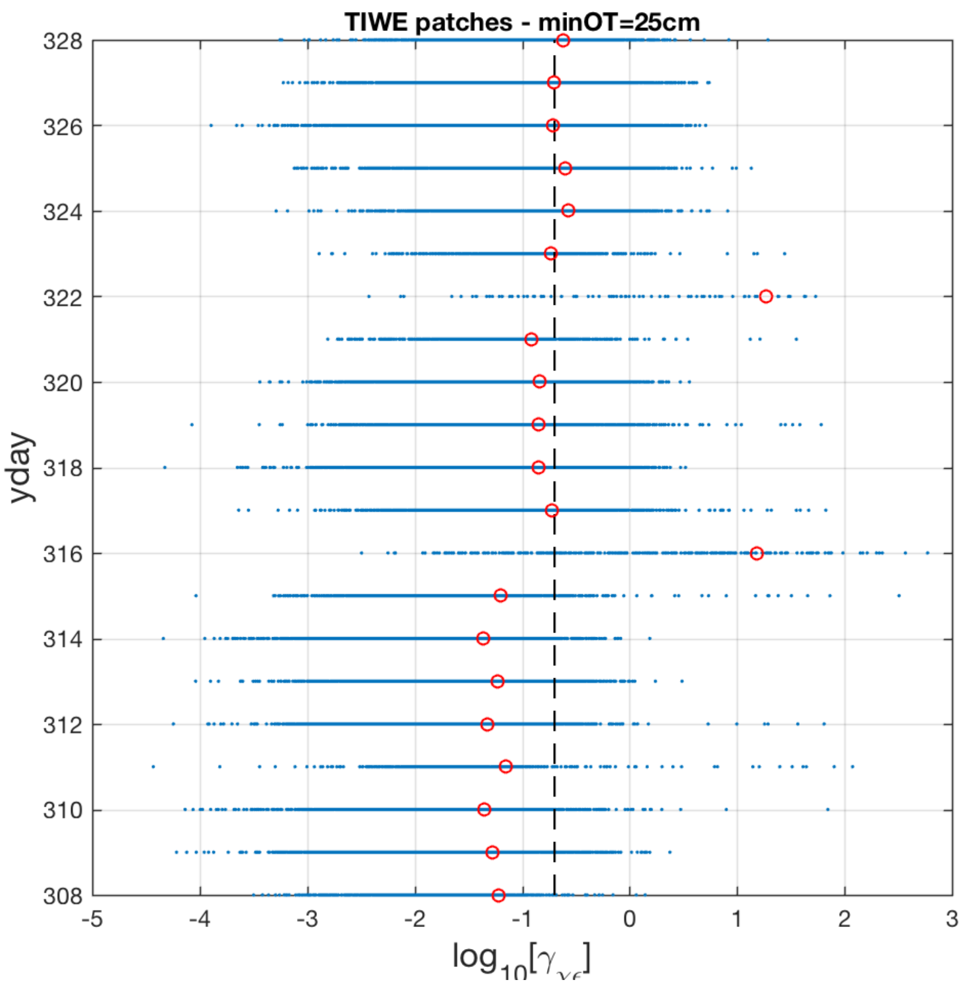

Figure 8: Plot of $\gamma_{\chi\epsilon}$ for patches vs yday. Vertical line is $\gamma_{\chi\epsilon} = 0.2$. Red circles are the median value for each day.