

Patch/Gamma Analysis for EQ14 chameleon patches

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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 $\gamma_{\chi\epsilon} = 0.2$.

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_tive_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 computed 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. $dtdz_{range}$: 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_{range}^2 : 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_{line}^2 : Fit a straight line to sorted potential density using `polyfit` to get $d\rho/dz$, then compute N^2 .
3. N_{bulk}^2 : Use 'bulk gradient' . This is calculated from the bulk T_z , using a linear fit between density and temperature.
4. N_4^2 : 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 different N^2 and dT/dz values.

$$\gamma_{\chi\epsilon} = \frac{N^2 \chi}{2\epsilon T_z^2} \quad (1)$$

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

1. γ_{range} : $N_{range}^2, dtdz_{range}$
2. γ_{line} : $N_{line}^2, dtdz_{line}$
3. γ_{bulk} : $N_{bulk}^2, dtdz_{bulk}$
4. γ_{range} : $N_4^2, dtdz_{line}$

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 data is about an order of magnitude less than 0.2 (Figure 1). 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 is about an order of magnitude less than 0.2 (Figure 3).

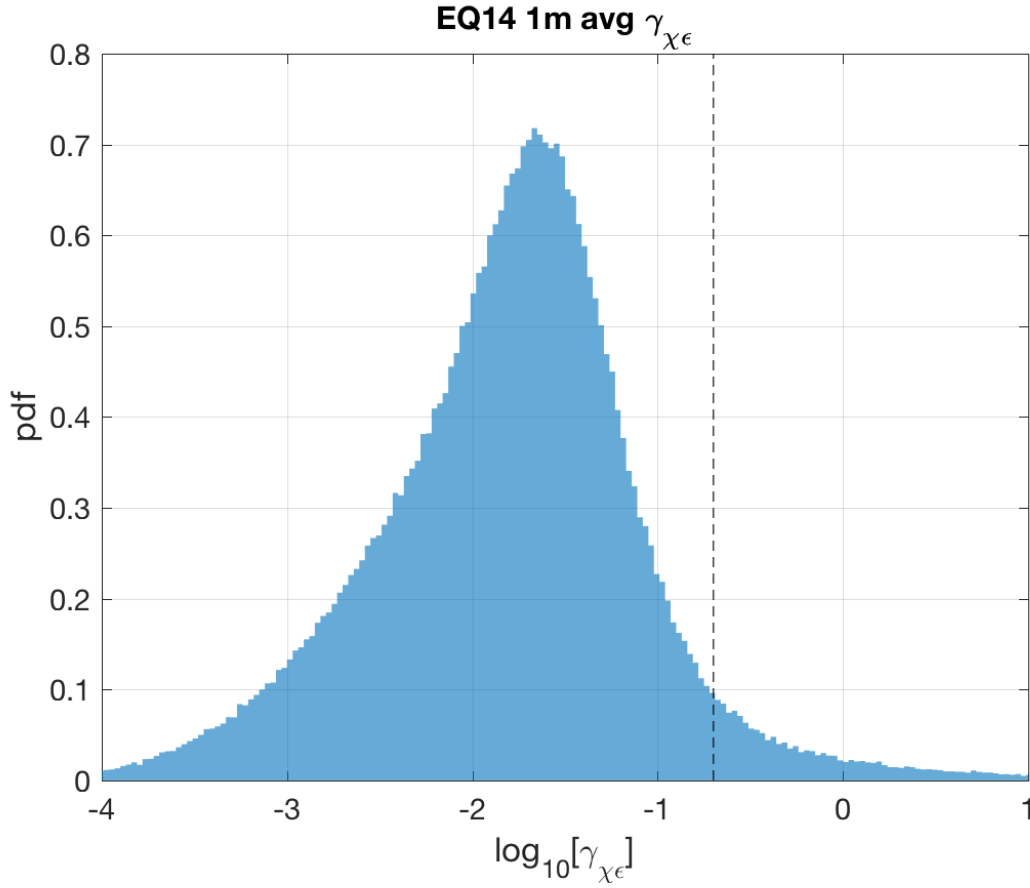


Figure 1: Histogram of $\gamma_{\chi\epsilon}$ for 1m avg chameleon profiles. Vertical dashed line shows $\gamma = 0.2$.

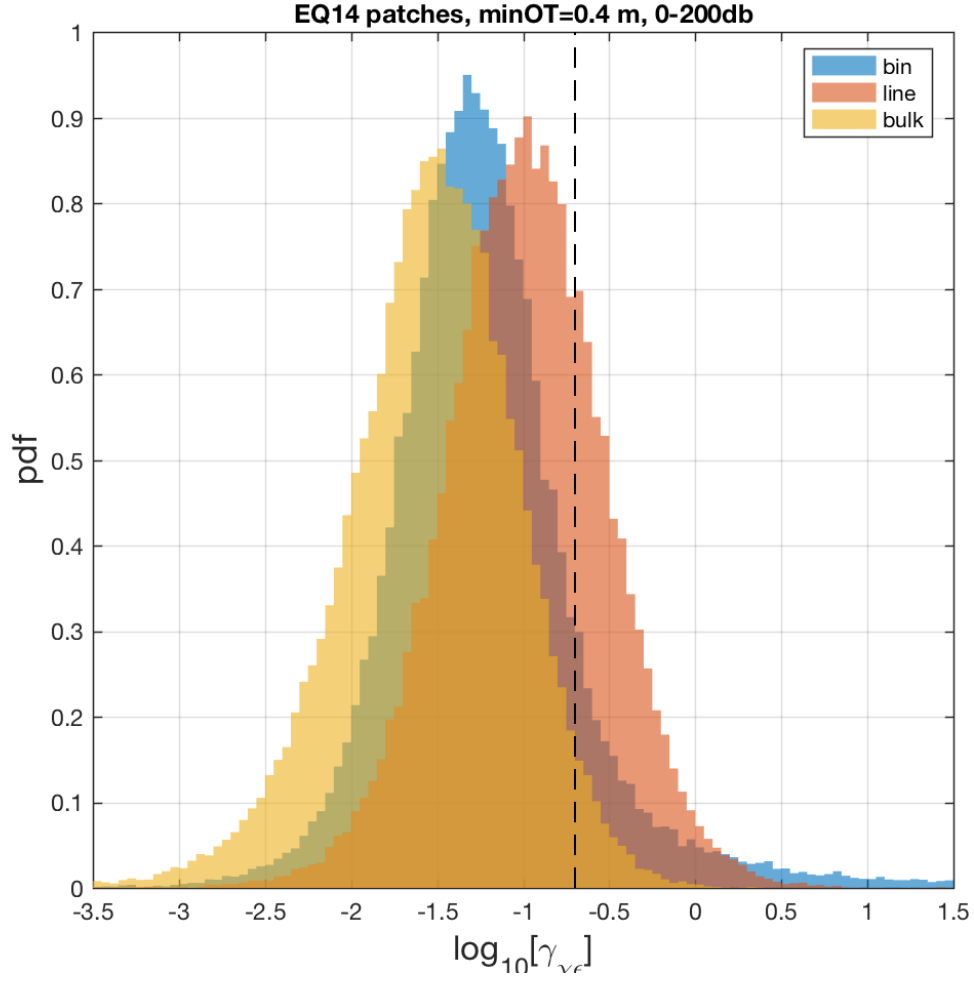


Figure 2: Histogram of $\gamma_{\chi\epsilon}$ for patches, using different estimates of N^2 and T_z . Vertical dashed line shows $\gamma = 0.2$. For all profiles, all depths.

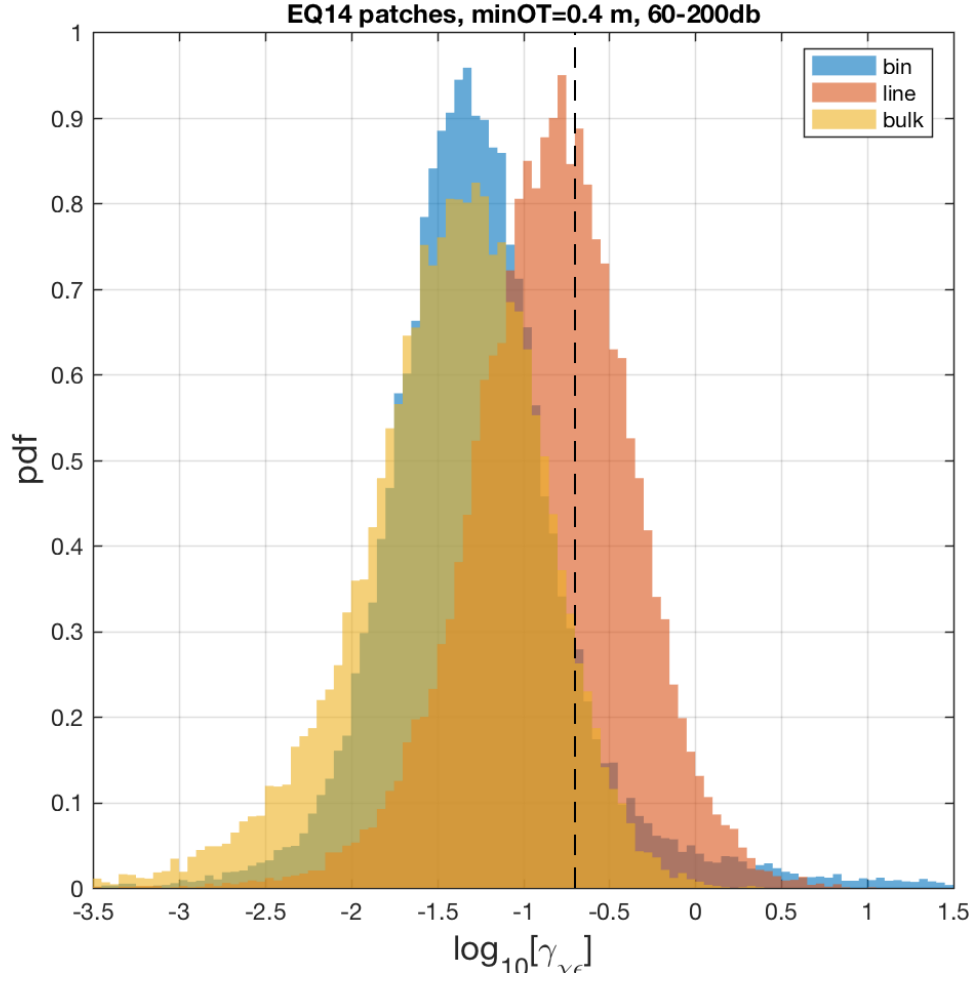


Figure 3: Histogram of $\gamma_{\chi\epsilon}$ for patches, using different estimates of N^2 and T_z . Vertical dashed line shows $\gamma = 0.2$. For all profiles, depths 60-200m only.

4.1 Using smaller fmax?

I believe the Chameleon data processed by Sally used the standard $f_{\text{max}}=32\text{Hz}$ correction/cutoff for the thermistor data. However when I was trying to apply the χ_{pod} 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 $f_{\text{max}}=7\text{hz}$. Estimates of $\gamma_{\chi\epsilon}$ are about 2-3 times larger (Figure 4), but still significantly less than 0.2 .

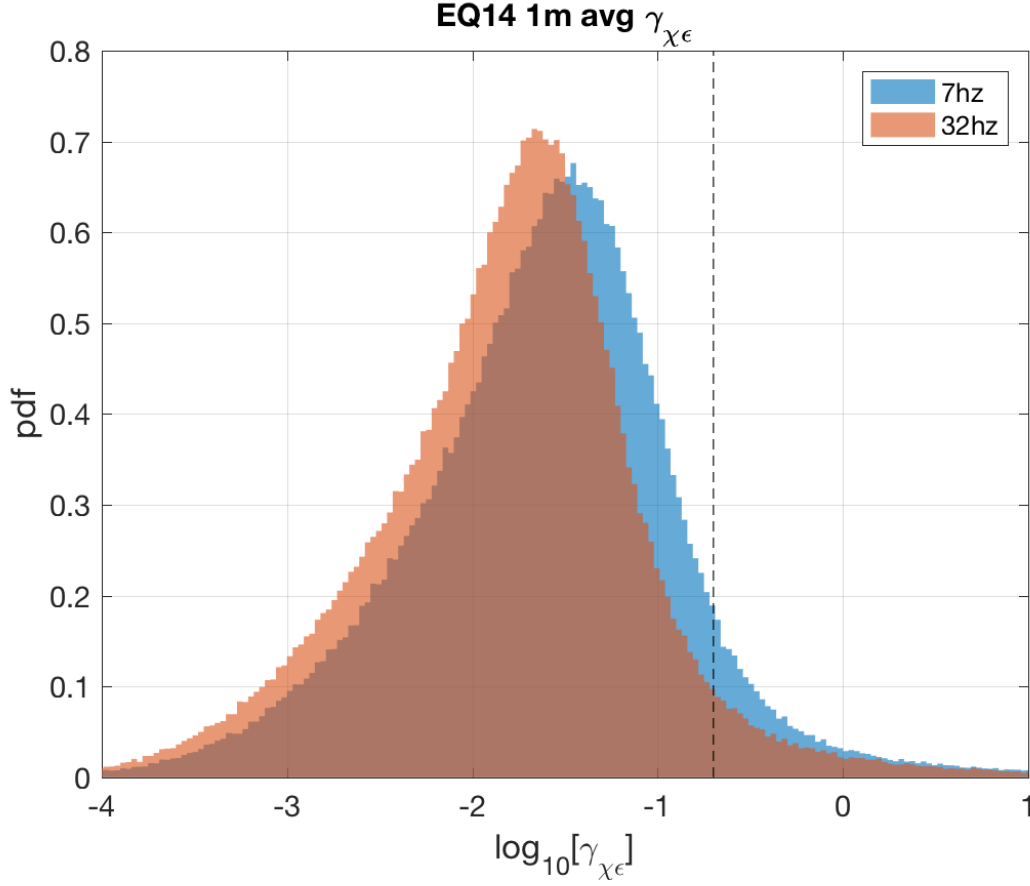


Figure 4: Histogram of $\gamma_{\chi\epsilon}$ for 1m avg chameleon profiles, for standard $f_{\text{max}}=32\text{hz}$ as well as $f_{\text{max}}=7\text{hz}$. Vertical dashed line shows $\gamma = 0.2$.

4.2 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 5).

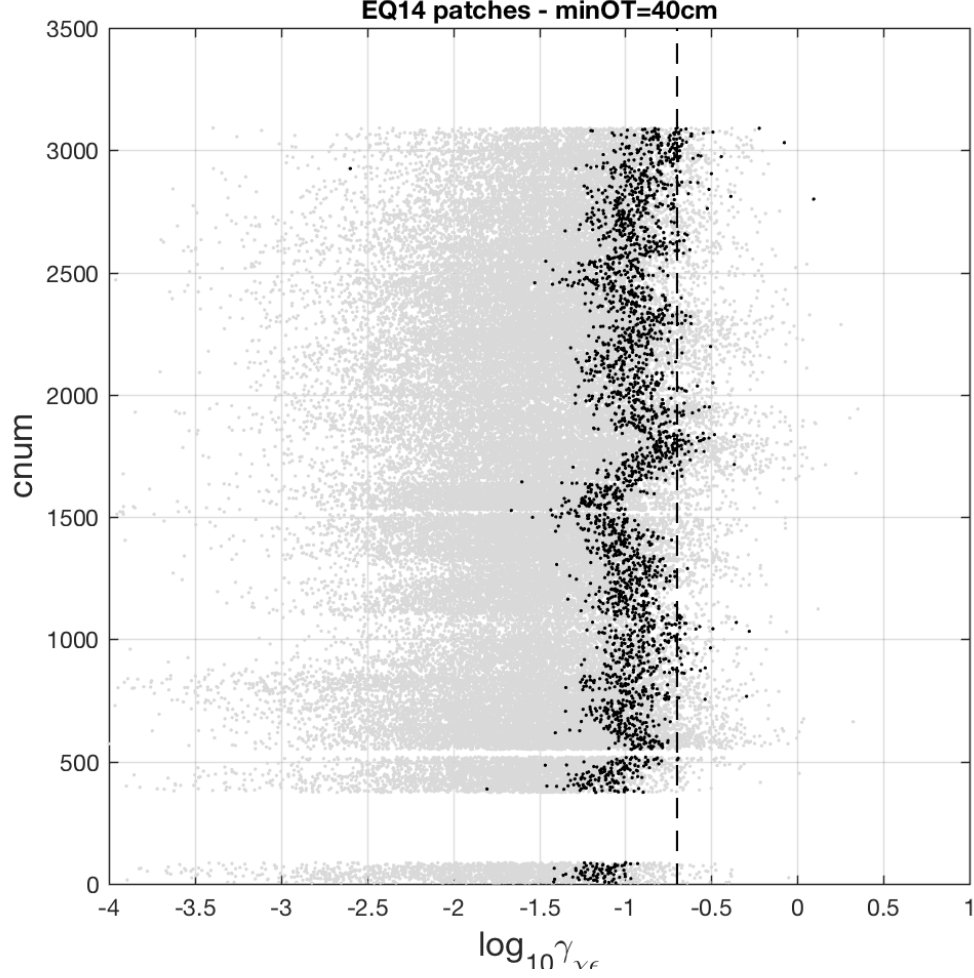


Figure 5: Plot of $\gamma_{\chi\epsilon}$ for patches vs cast number. Vertical line is $\gamma = 0.2$. Black points are the median value for each cast.

4.3 Variation of $\gamma_{\chi\epsilon}$ over depth?

plot_gamma_vs_depth_eq14.m

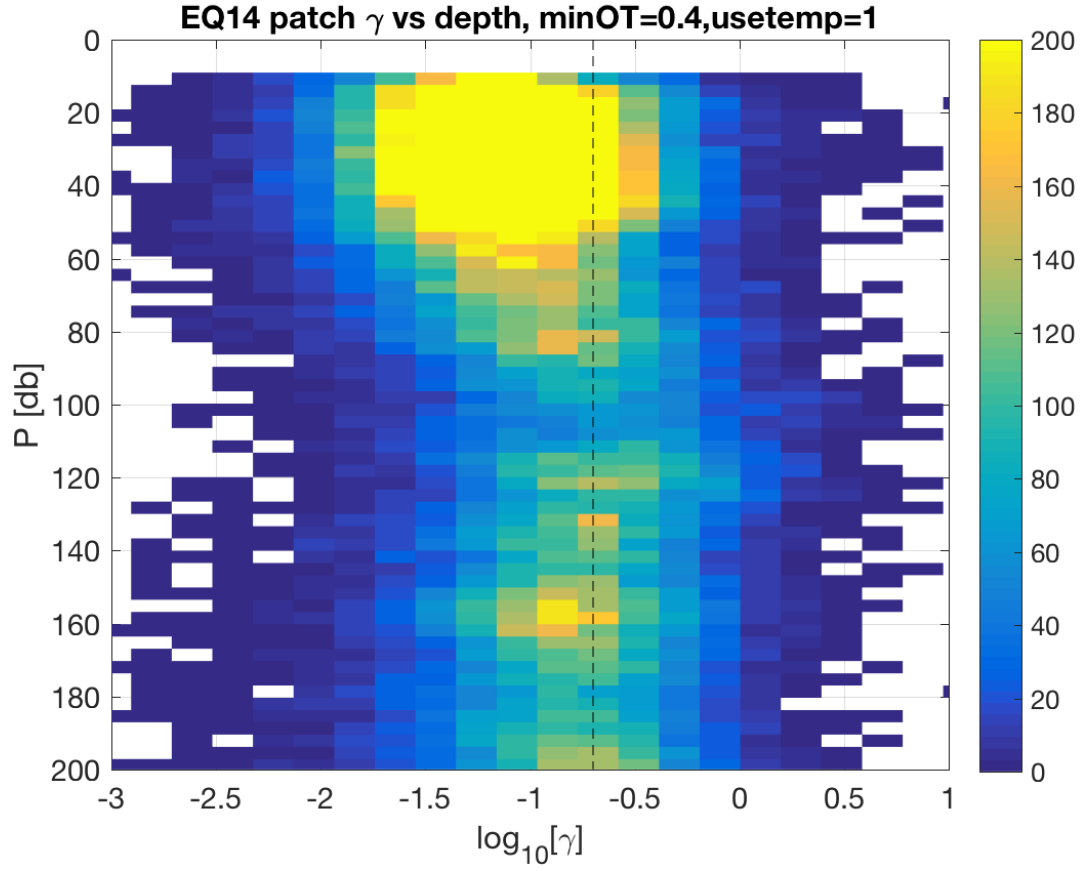


Figure 6: Plot of $\gamma_{\chi\epsilon}$ for patches? vs depth. Vertical line is $\gamma = 0.2$.

5 Summary

- γ_{χ^e} computed from 1m binned data (the standard Chameleon processing) is about 10 times smaller than the typical assumed value of 0.2.
- γ_{χ^e} computed for just patches is larger. If only depth range 60-200m used, gamma using ‘line’ method is about 0.2.
- γ_{χ^e} does not appear to vary much over time/cast number, as was seen in tiwe data.