Patch/Gamma Analysis for EQ14 chameleon patches

Andy Pickering

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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_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. $dtdz_{range}$: 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 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_{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

- $\gamma_{\chi\epsilon}$ computed for binned data and just over patches is about an order of magnitude less than 0.2 (Figure 2).

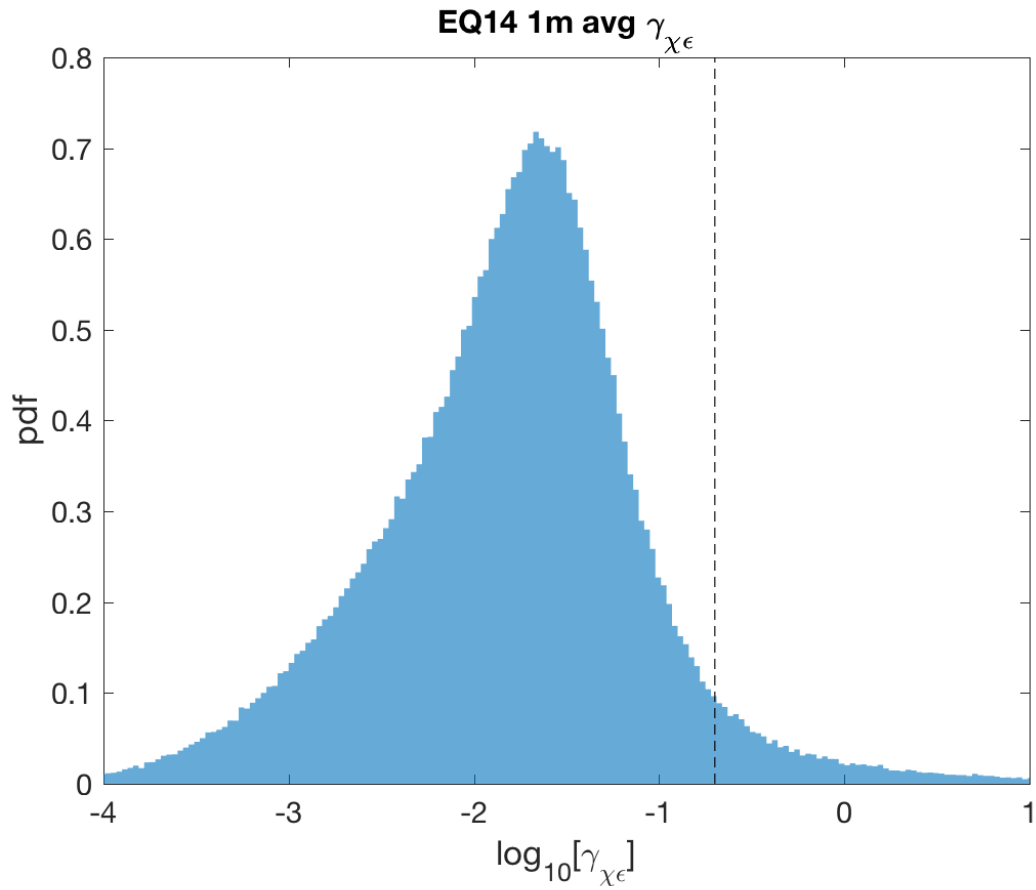

Figure 1: Histogram of $\gamma_{\chi\epsilon}$ for 1m avg chameleon profiles. Vertical dashed line shows $\Gamma = 0.2$.

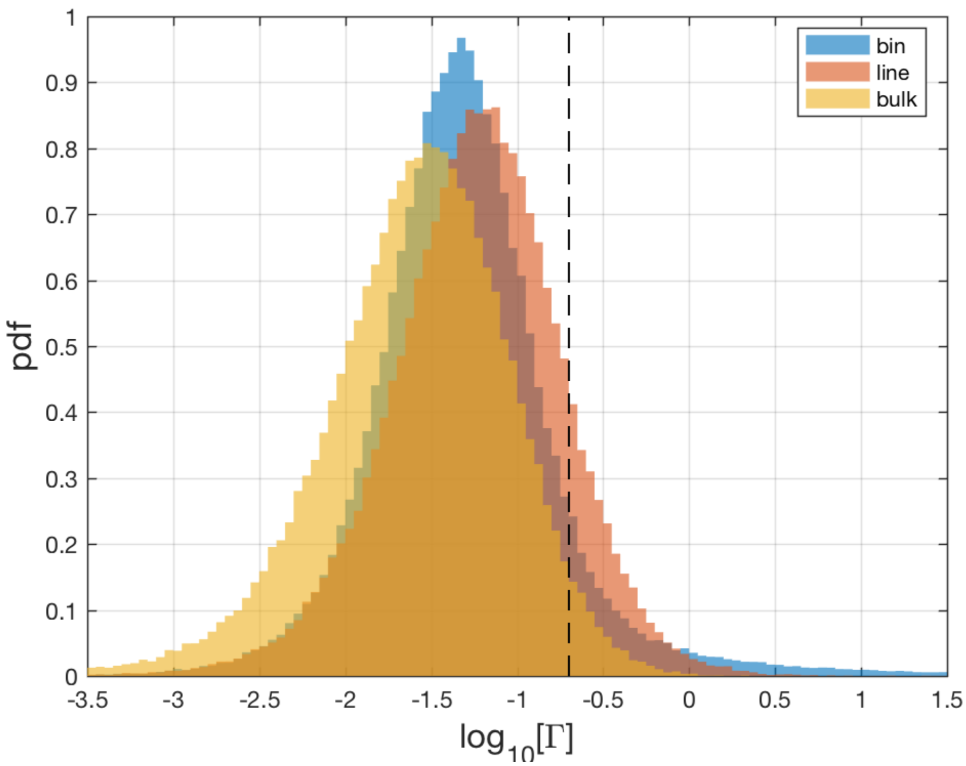

Figure 2: Histogram of $\gamma_{\chi\epsilon}$ for patches, using different estimates of N^2 and T_z. Vertical dashed line shows $\gamma = 0.2$. For all profiles.

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

To investigate whether $\gamma_{\chi\epsilon}$ varies over time, I plotted $\gamma_{\chi\epsilon}$ vs yday (Figure 3).

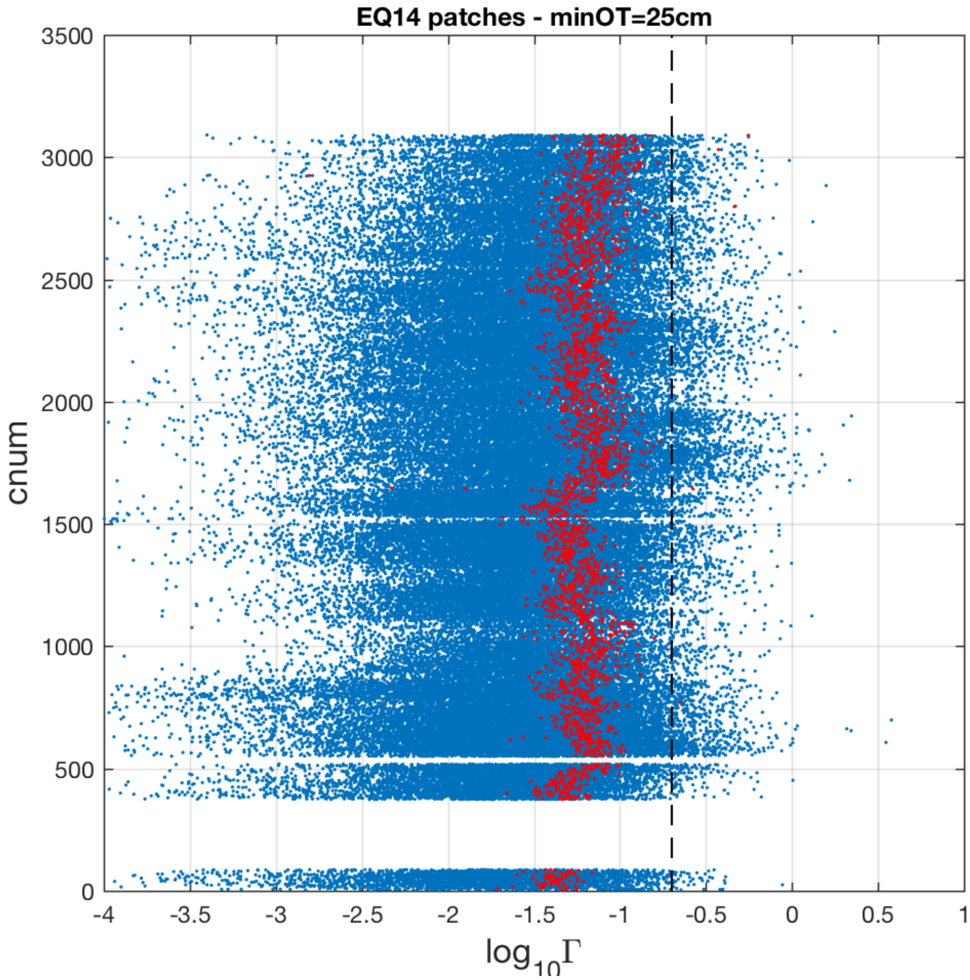

Figure 3: Plot of $\gamma_{\chi\epsilon}$ for patches vs cast number. Vertical line is $\gamma = 0.2$. Red circles are the median value for each cast.

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 is similar (slightly larger?).
- $\gamma_{\chi\epsilon}$ does not appear to vary over time/cast number, as was seen in tiwe data.