χpods and Mixing Efficiency

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The CTD-χpod

- Measures temperature gradient w/ FP07 thermistor
- Easily deployed on traditional CTD, Tz not as sensitive to package vibration
- Goal is to be able to estimate χ and ϵ w/o full microstructure

χpod Method

In small windows:

- Convert dT/dt to dT/dz using fallspeed
- Compute spectra of dT/dz
- Iterative method to estimate χ,ϵ
- Assumes $K_T = K_\rho$
- Assumes mixing efficency (coefficient) $\gamma = 0.2$

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

CTD-χpod Validation

- To validate, compare w/ Chamelon microstructure profiles (1m avg).
- Apply χpod method to Chameleon thermistor data only (no shear probes)
- Compare to Chameleon estimates using shear probes.

Results:

- χ compares well
- But ϵ biased low by about 10X

Why is ϵ Biased so Low?

- Turns out using the 1m avg Chameleon data, $\gamma \approx 0.02$, not 0.2 .
- Apparently Sasha found something similar for EQ08 and other Chameleon datasets?

What if We Compute γ over patches?

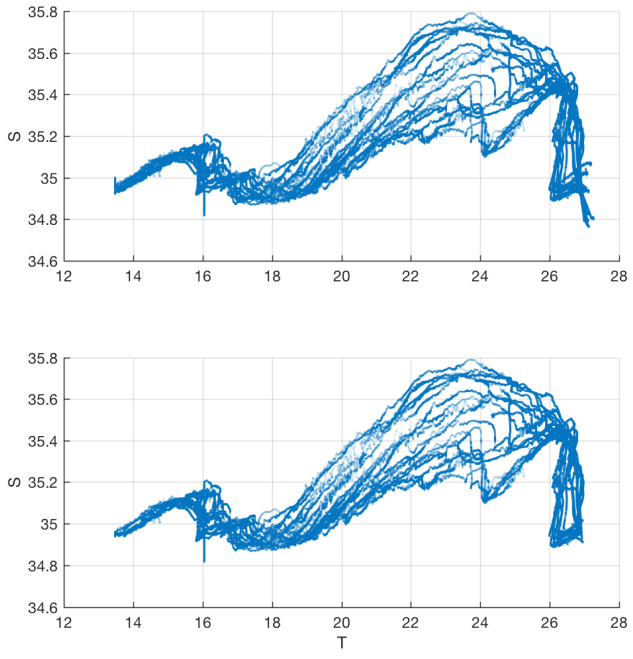
- But everyone says $\gamma = 0.2$...
- Maybe we have to compute it over patches. If there's no mixing, does γ even make sense?
- So began the journey into patches...

Patches

- Turns out computing γ over patches not so simple...
- Lots of options for how to identify patches, calculate T_z and N^2 etc.
- Lots of salinity spikes, need to use temperature.
- Use 60-200m only (don't include diurnal cycle turbulence etc.)

Salinity spikes

- Salinity looks noisy, lots of spikes.
- Not a constant T-S relationship
- use R^2 to quanity 'tight' T-S relationships in patches?



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dT/dz and N2

T_z:

- T_z ''line' : Fit a straight line to sorted temperature within patch.
- T_z 'bulk' : Method from Smyth et al 2001. More robust when there are multiple layers within patch?

N^2:

- N^2 ''line' : Fit a straight line to sorted density within patch.
- N^2 ''fit' : Fit a straight line to density computed from T-S fit in patch.
- N^2 'bulk' : Use 'bulk' T_z, and ratio between density and temperature.

γ

This gives us 4 estimates of γ:

- γ bin : Binned T_z,N^2 interopolated to patch locations.
- γ ''line' : 'line' T_z,N^2
- γ 'bulk' : 'bulk' T_z,N^2
- γ 'linefit' : 'line' T_z,, ''line-fit' N^2

Overview

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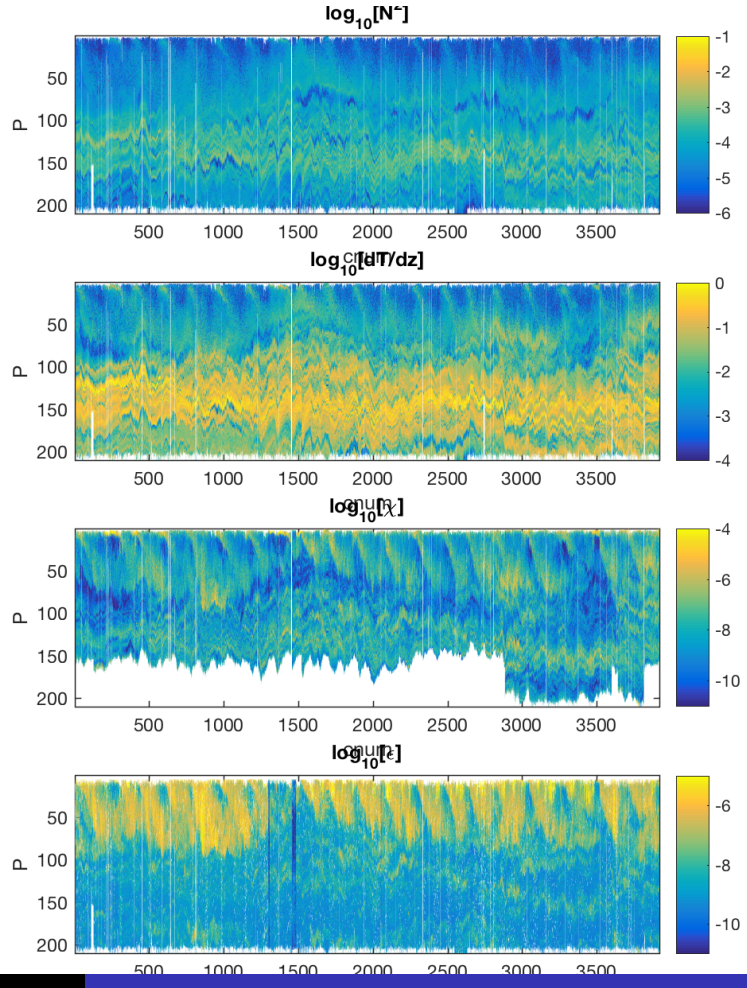

log10[N²]
log10[dT/dz]
log10[χ]
log10[ε]
P
50
100
150
200
500
1000
1500
2000
2500
3000
3500

TIWE binned

- Looked at TIWE 1st because there were some previous patch analayis and gamma estimates (Bill,Jim).
- Binned gamma has median of ...

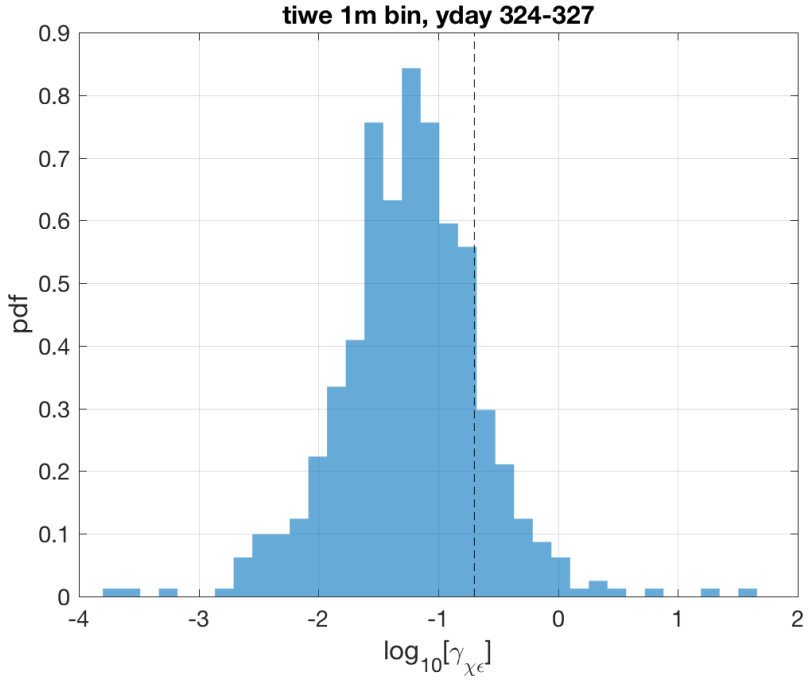
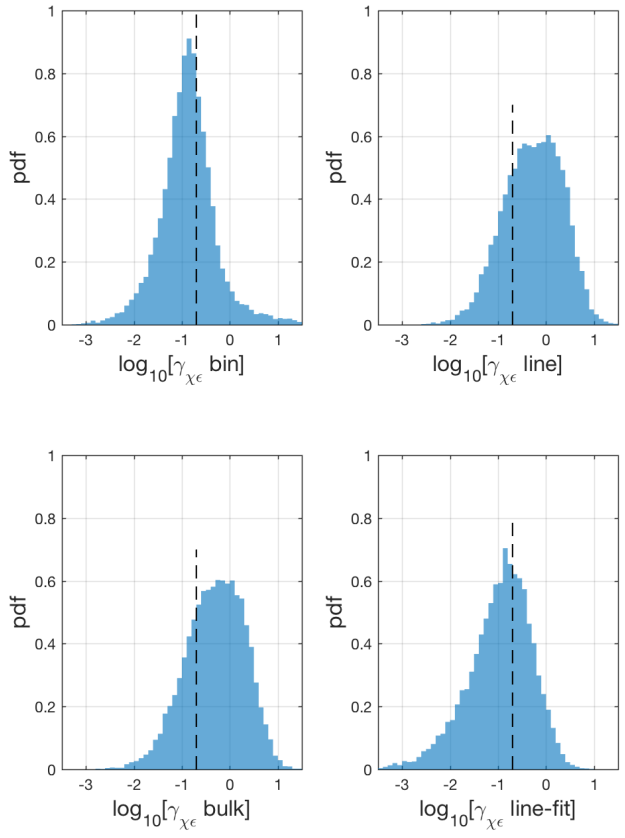


Figure: γ estimated from 1m binned

TIWE patch

- Patch estimates of γ are all equal or greater than 0.2
- 'bin' and ''line-fit' are centered close to 0.1 . 'line' and 'bulk' are centered greater than 0.2



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Results table

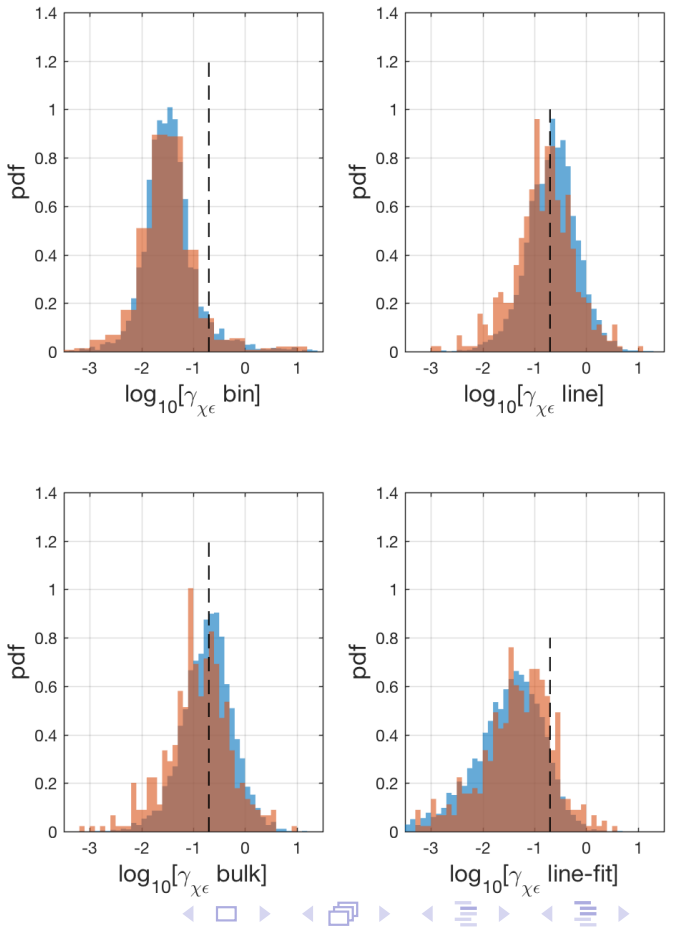
Table: Statistics for patches using various parameters. γ values are medians for each distribution. Only patches between 60-200m and on yday 324-327 are considered for all.

minOT	usetemp	minR2	γbin	$\gamma line$	γfit	$\gamma bulk$	Npatches
0.4	1	0	0.13	0.57	0.11	0.53	16329
0.4	1	0.5	0.14	0.22	0.12	0.21	3761
0.75	1	0	0.15	0.62	0.14	0.59	9175
0.75	1	0.5	0.15	0.25	0.16	0.26	2358
1	1	0	0.16	0.71	0.15	0.68	6893
1	1	0.5	0.16	0.29	0.17	0.29	1779

EQ14 1

EQ14 2

- Patch estimates of γ vary depending on method used.
- bin and line-fit are smaller than 0.2. line and bulk are centered near 0.2 .



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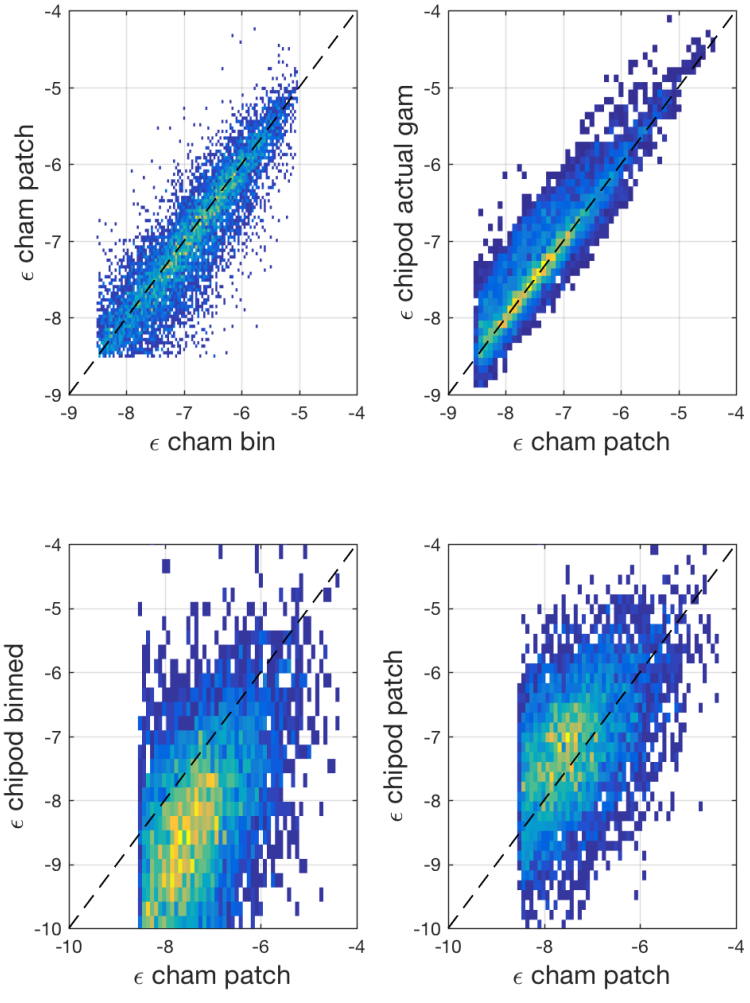
EQ14 3

Table: 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



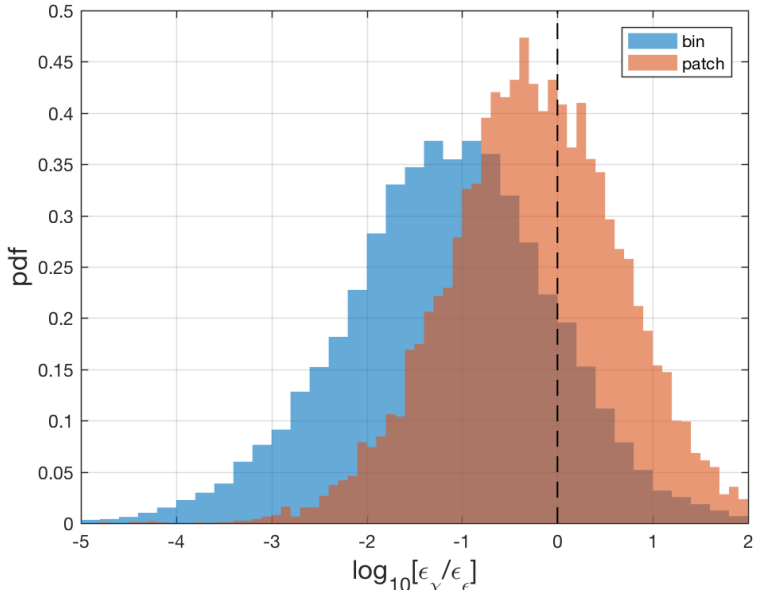


Figure: Ratio of χpod estimated ϵ to Chameleon ϵ for patches.

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Summary

- γ sensitive to many choices of parameters/methods. Difficult to tell if γ actually changes.
- In general, it seems that using 1m binned data tends to give γ smaller than 0.2, while using patches gives something closer to 0.2 .
- Suggests we should be using some kind of patch values in CTD χpod calculations (since a constant $\gamma = 0.2$ is assumed).
- Applying χpod method to patches from EQ14 Chameleon profiles improves magnitude of ϵ estimates, but dependence on actual ϵ may be off.