

Lomb-Scargle your way to RSFC parameter estimation in AFNI-FATCAT

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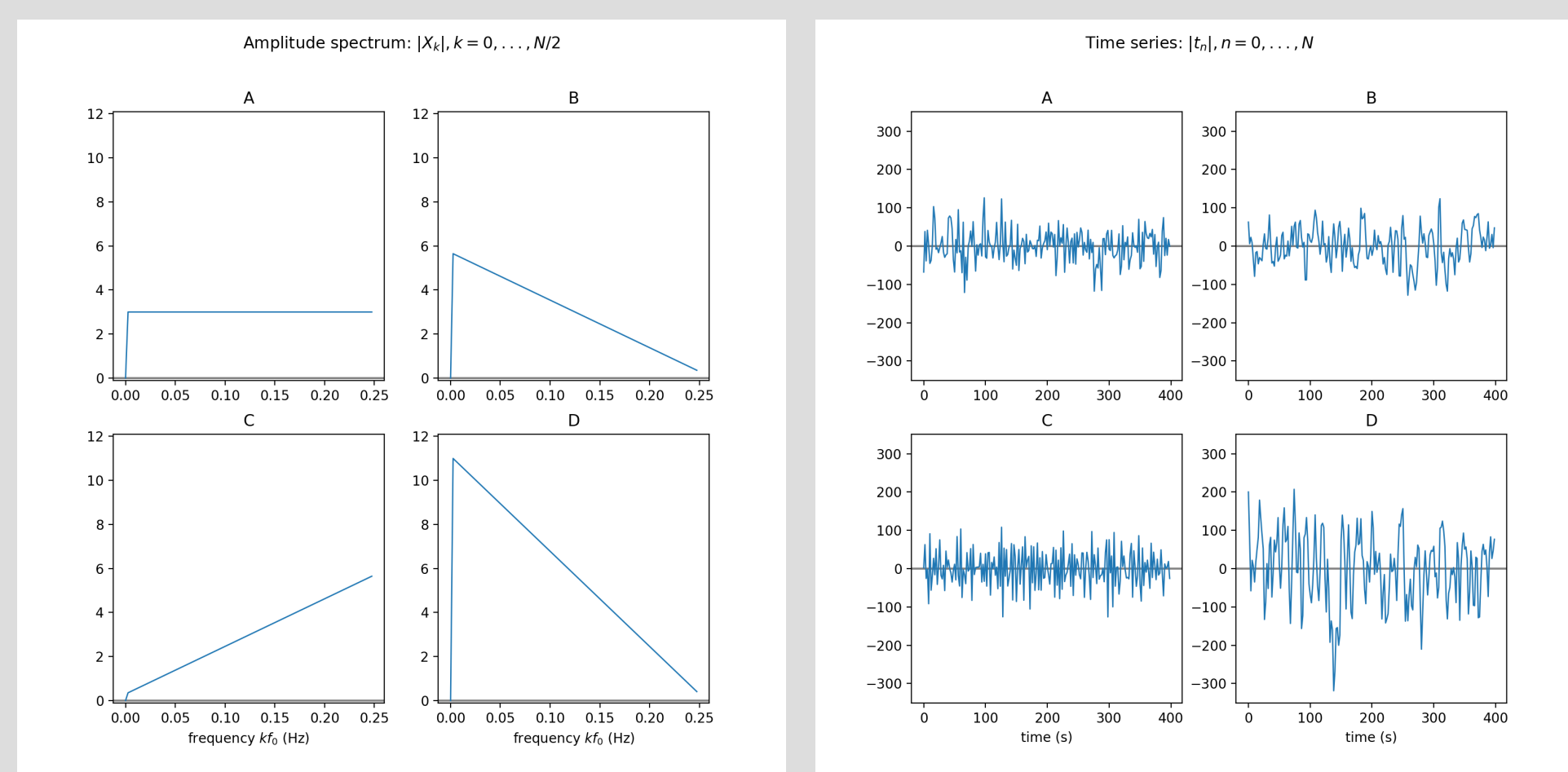


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- + FMRI data processing often includes a step of **censoring**: removing time points when a subject moved a lot.
- + Many resting state functional connectivity (RSFC) parameters (e.g., ALFF¹, fALFF², RSFA³) use **spectral information**.
 - Standard power spectra are typically calculated using the Fourier Transform/Series (FT)
- + **A problem**: The FT *cannot* be applied when censoring is done (the FT requires uniform time sampling).
- + **A solution**: The **Lomb-Scargle (L-S) periodogram**^{4,5} generates spectra in non-uniformly sampled time series.
 - We describe using this general method to get power/amplitude spectra and RSFC parameters in AFNI-FATCAT^{6,7}.

Data simulation setup

- + 4 time series ($N = 200$ time points, $TR = 2$ s)
- + Known spectral amplitudes, random phases

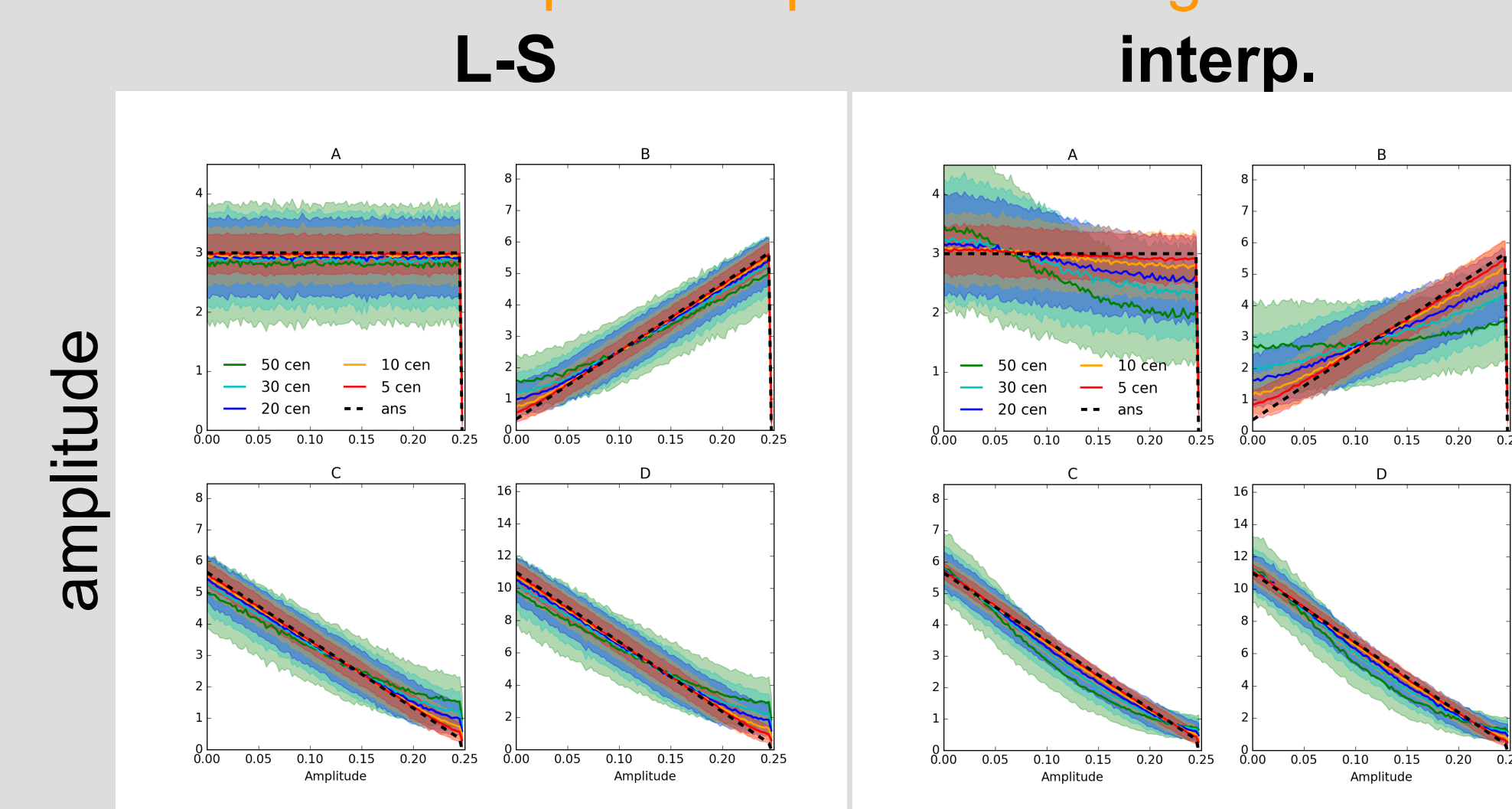


Simulations

- + Randomly choose points to censor at 5 levels: 5, 10, 20, 30, 50
- + Number of repetitions: 1000
- + Low frequency fluctuation (LFF) band: 0.01-0.1 Hz
- + Calculate properties for
 - 1) Lomb-Scargle (L-S)
 - 2) interpolation (interp.)
- + Compare estimates for:
 - 0) averages of all simulation spectra
 - 1) sums of full spectra: power and amplitudes
 - 2-3) RSFC parameters: ALFF, fALFF, RSFA, fRSFA

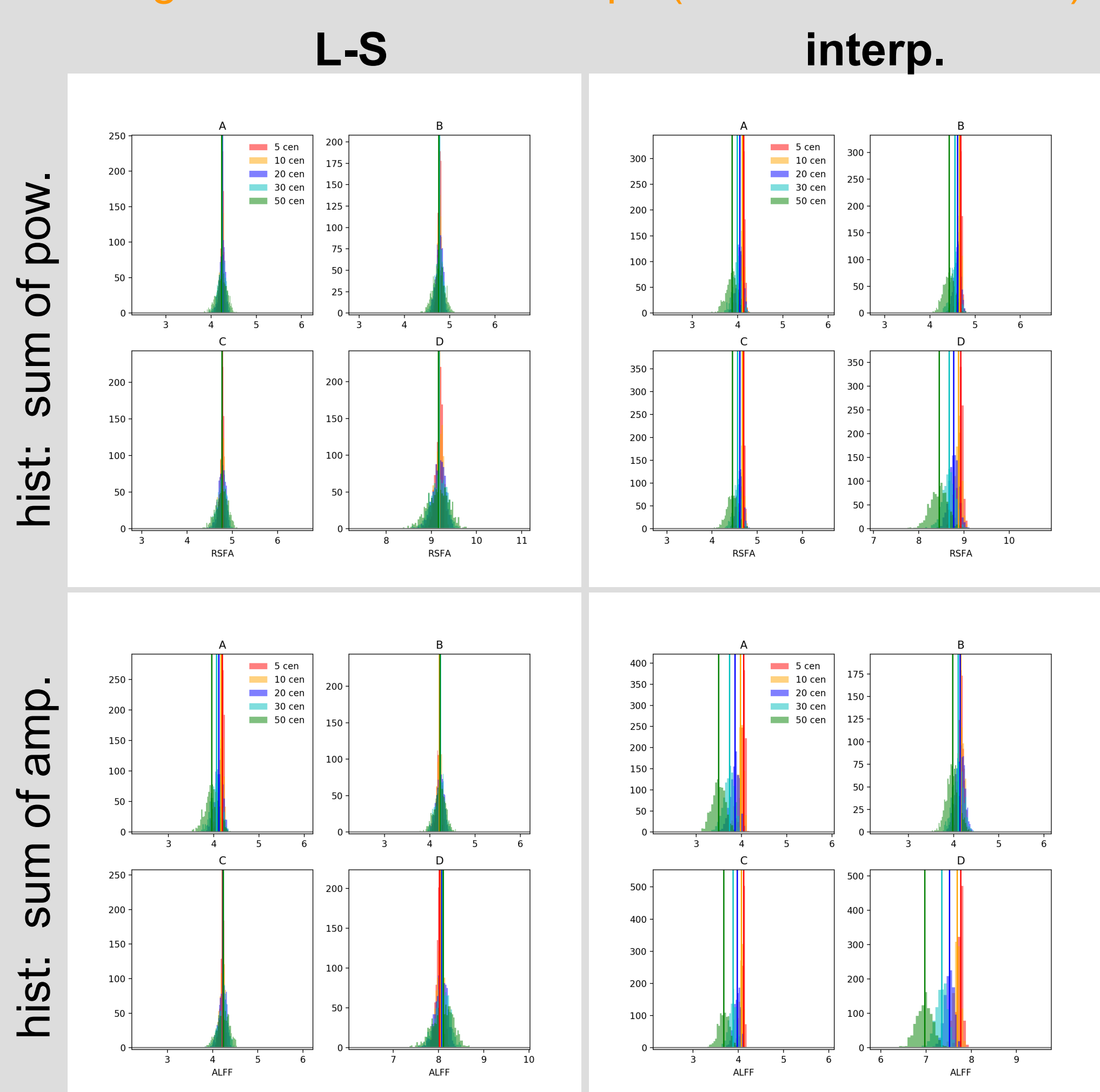
Comparison #0: average simulation spectra

All simulation amplitude spectra: average \pm sdev



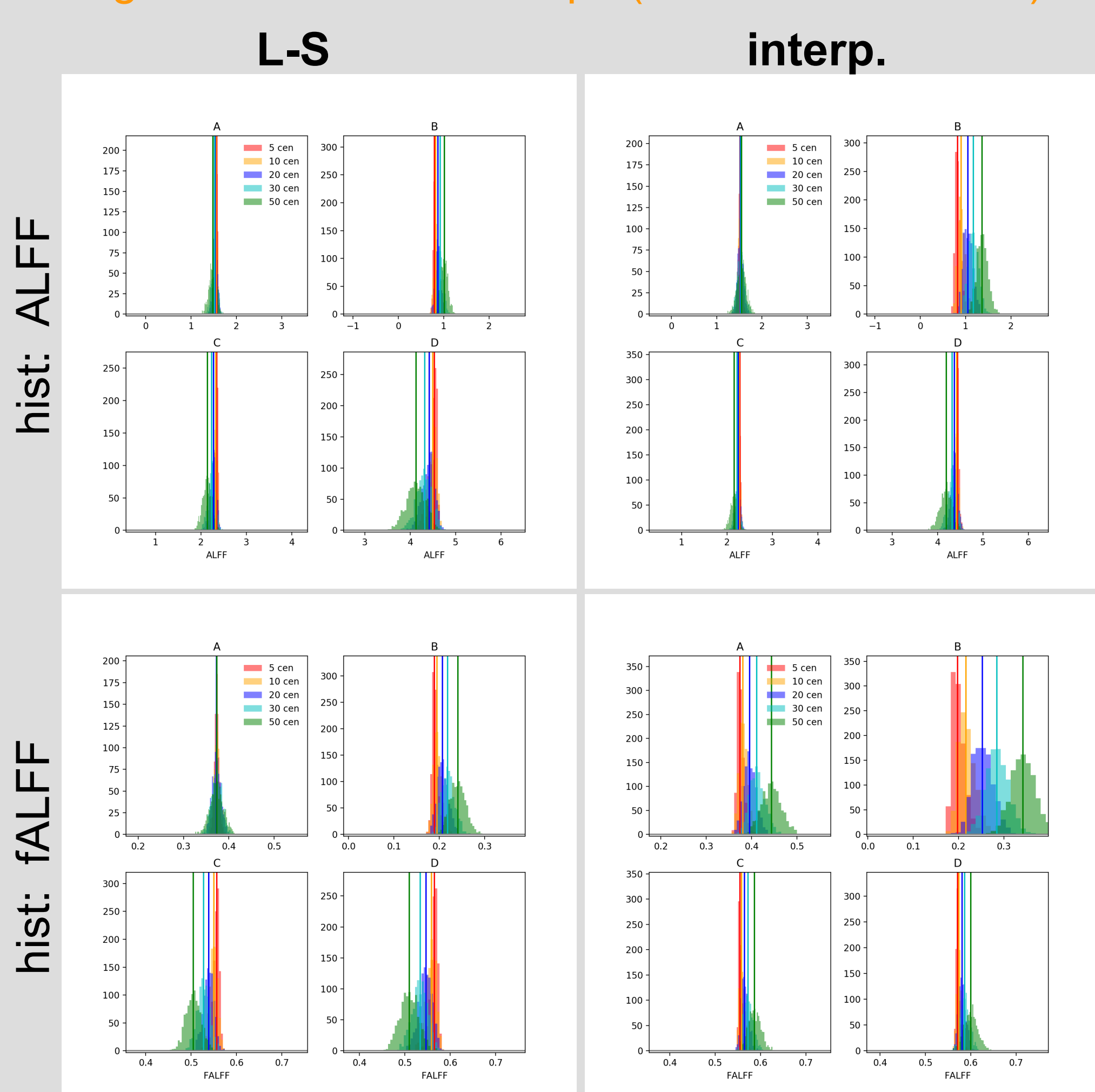
Comparison #1: estimates for full spectrum

histogram for each 1000 reps (vert. line is median)



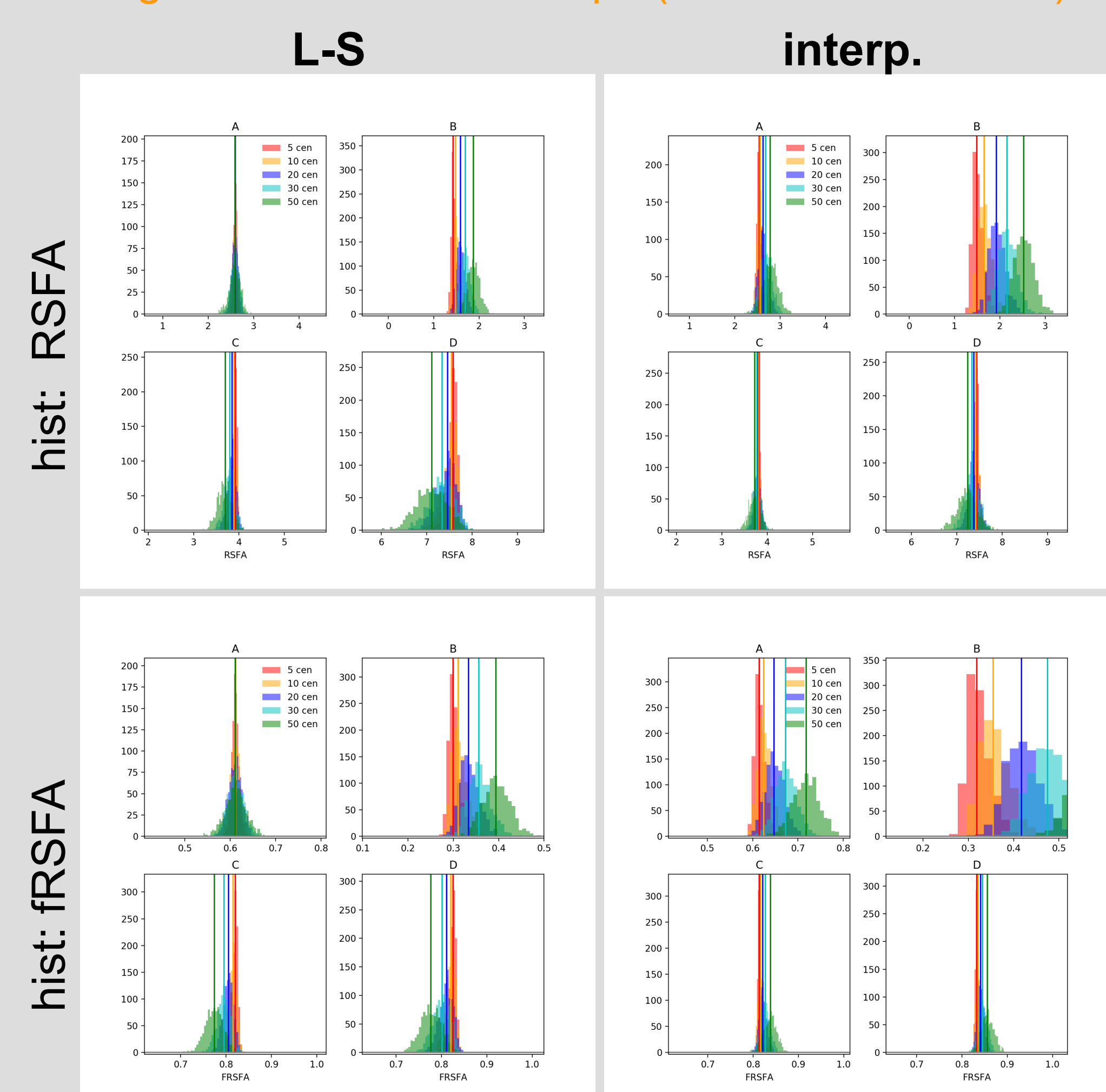
Comparison #2: estimates for ALFF + fALFF

histogram for each 1000 reps (vert. line is median)



Comparison #3: estimates for RSFA + fRSFA

histogram for each 1000 reps (vert. line is median)



- + The Lomb-Scargle periodogram preserves the overall power in the spectrum (Parseval's Relation).
- + Averages of the 1000 simulation spectra from L-S showed more robust matching with the uncensored spectra.
- + In many (but not all) cases, the L-S method shows more consistency for RSFC parameters than interpolation.
- + Comparing RSFC parameters across subjects with very different amounts of censoring remains difficult.
 - more work is still needed on this topic for RSFC parameters to be calculated properly in the presence of censoring.

Refs.

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- [6] Cox RW. 1996. Comput Biomed Res 29:162-173
- [7] Taylor PA, Saad ZS. 2013. Brain Connect 3:523-535

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