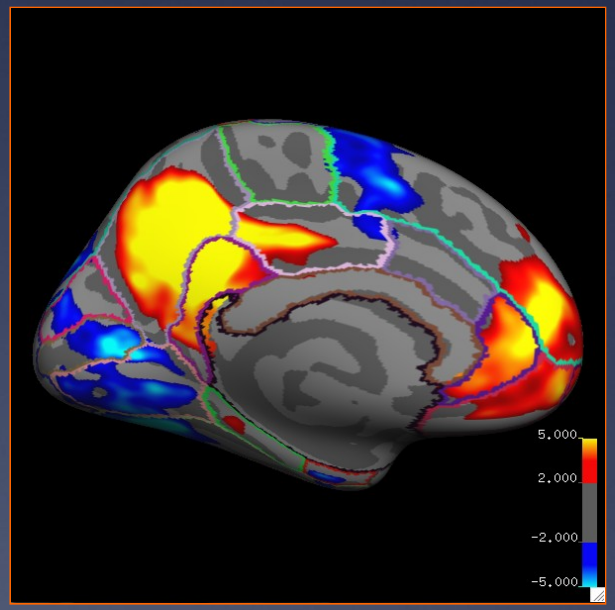
Nuisance Signals in R-fMR

Global Signal =

a1 * GM + a2 * WM + a3 * CSF + ?.

Who is dominant contributor in these weights: a1, a2, a3?



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Questions

Given: Numerous approaches exist for the extraction of time-series data for nuisance signals in RSFC analyses.

Do they highly affect the RSFC results w/o them in the model?

Do nuisance signals significantly correlated with each other? Who is more important?

What should we use? High reliability?

What is the meaning of global mean signal?

Three Types of Nuisances

Head motion nuisances: 3 displacements and 3 rotations.

Non-gray matter nuisances: WM, CSF, other noise regions (NOISE).

Gray matter nuisances: global mean signal (GLS), global mean signal after removal of CSF and WM signals (GLSDT), gray matter mean signal (GM).

We focus on the latter two types.

Non Gray Matter Nuisances

WM: three extracting methods, 1) participant-specific tissue segmentation where tissue probability is more than 50% (SEG), 2) tissue seed (26, -12, 35) in Chang's et al. (2009) (SEED); 3) TC-GICA combing dual regression (ICA-DR) in Zuo et al. (NeuroImage, 2010);

CSF: three extracting methods, 1) participant-specific tissue segmentation where tissue probability is more than 50% (SEG), 2) tissue seed (19, -33, 18) in Chang's et al. (2009) (SEED); 3) TC-GICA combing dual regression (ICA-DR) in Zuo et al. (NeuroImage, in press);

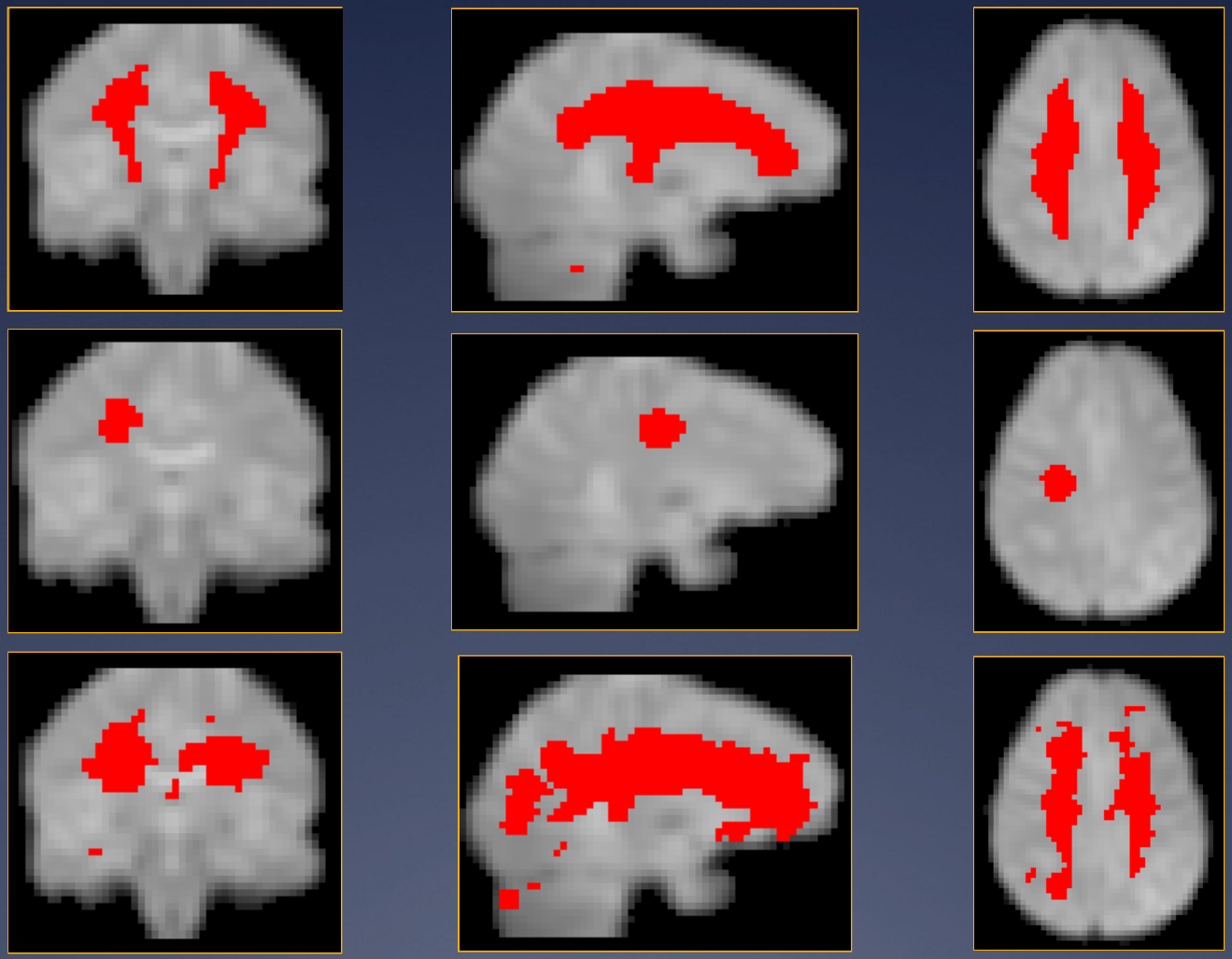
Noise regions defined by our previous amplitude study (NOISE) (Zuo et al., NeuroImage, 2010);

WM Masks

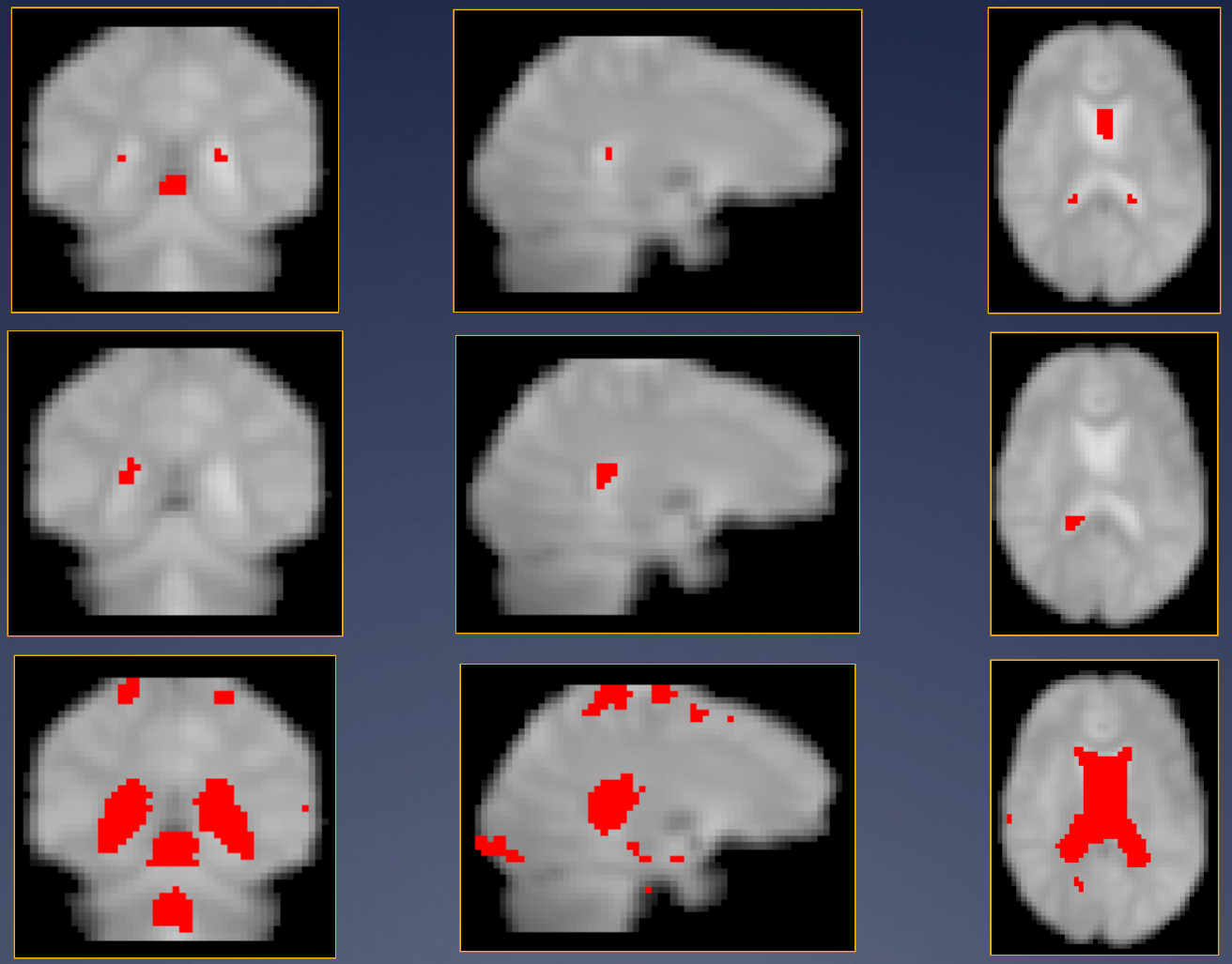
SEG

SEED

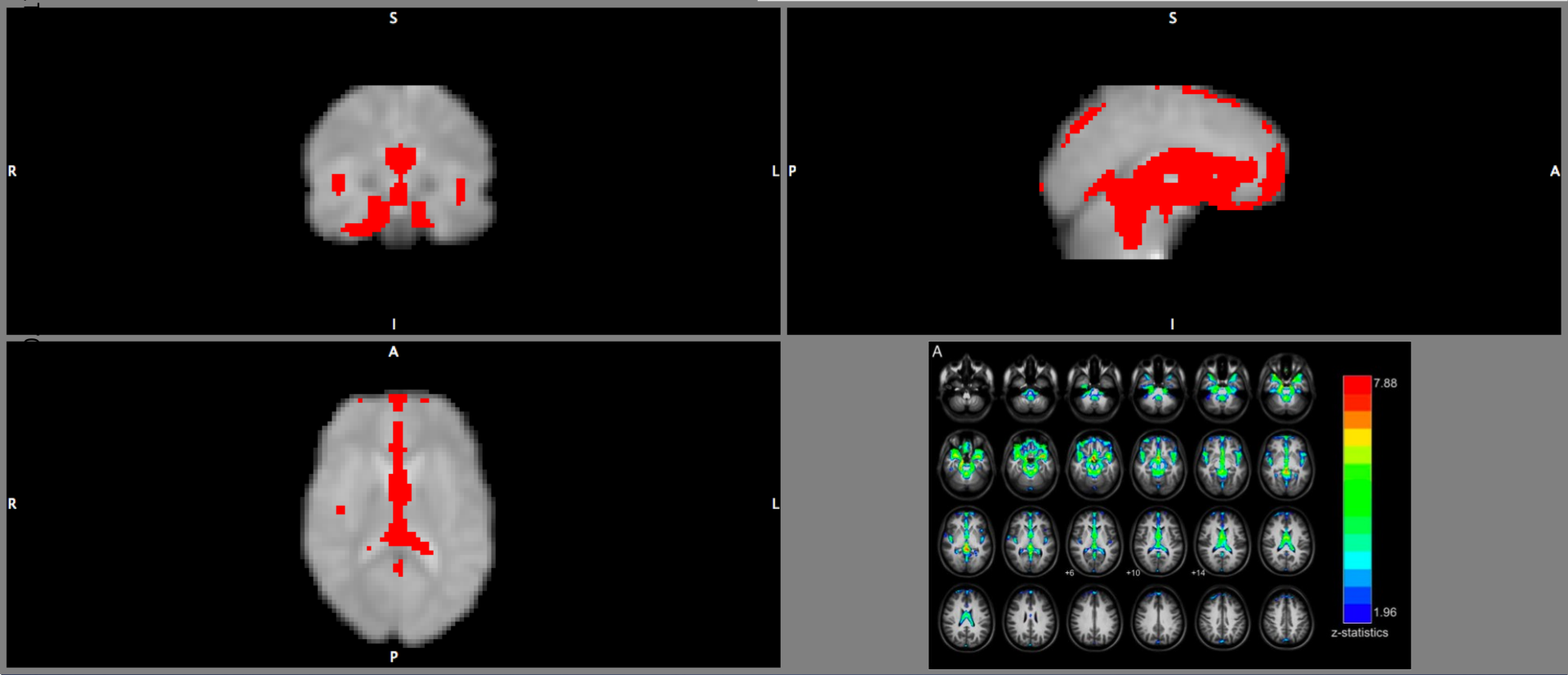
ICA-DR



CSF Masks



(ALFF - fALFF) Derived Nuisance Signal Mask



NOISE

Figure 3A in Zuo et al., NeuroImage, 2010.

Gray Matter Nuisances

GLS: a mean timeseries within a full brain mask;

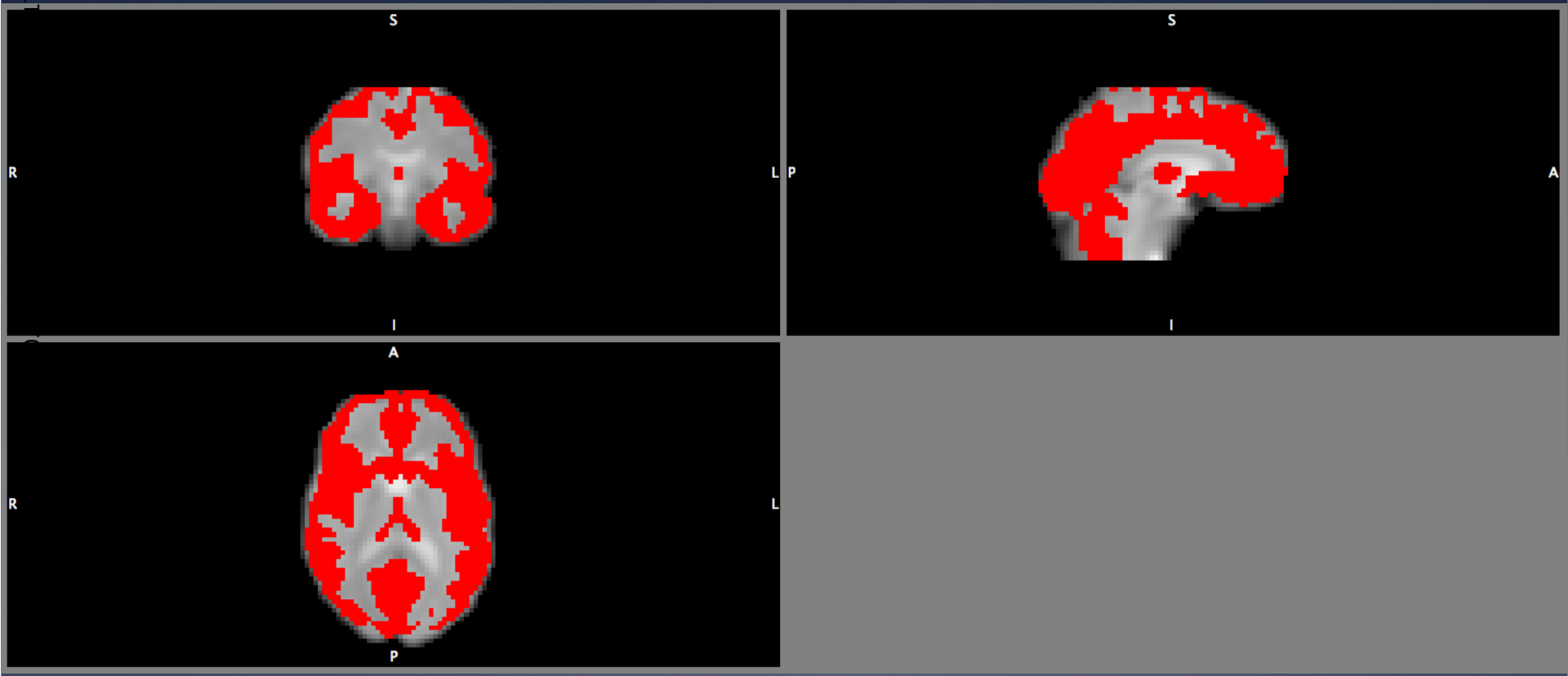
GM-SEG: a mean timeseries within a segmentation-based GM mask;

GM-fALFF: a mean timeseries within a gray matter mask based on our previous amplitude study (Zuo et al., in press).

GLSDT: global signal following removal of WM/CSF nuisance signals.

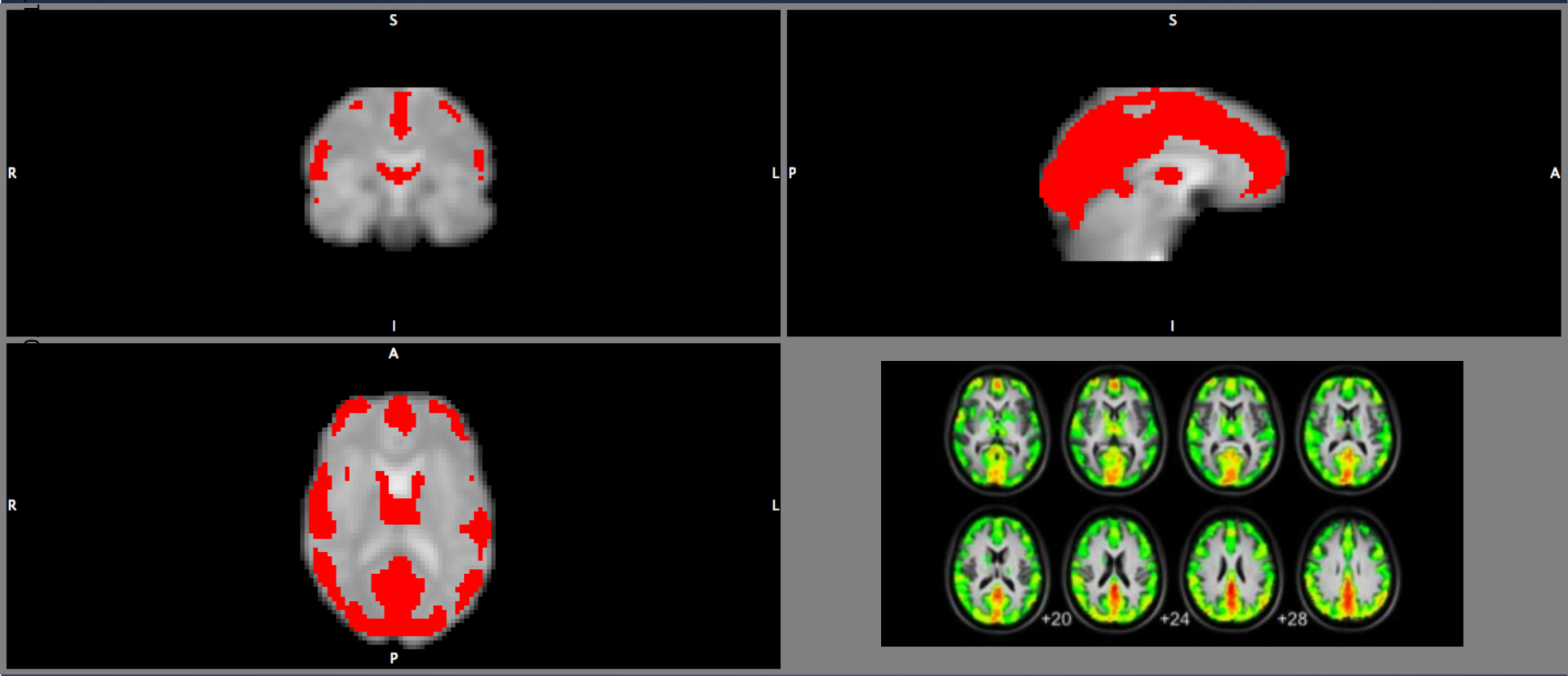
Gray Matter Mask: segment

17 Apr 2010



GM-SEG

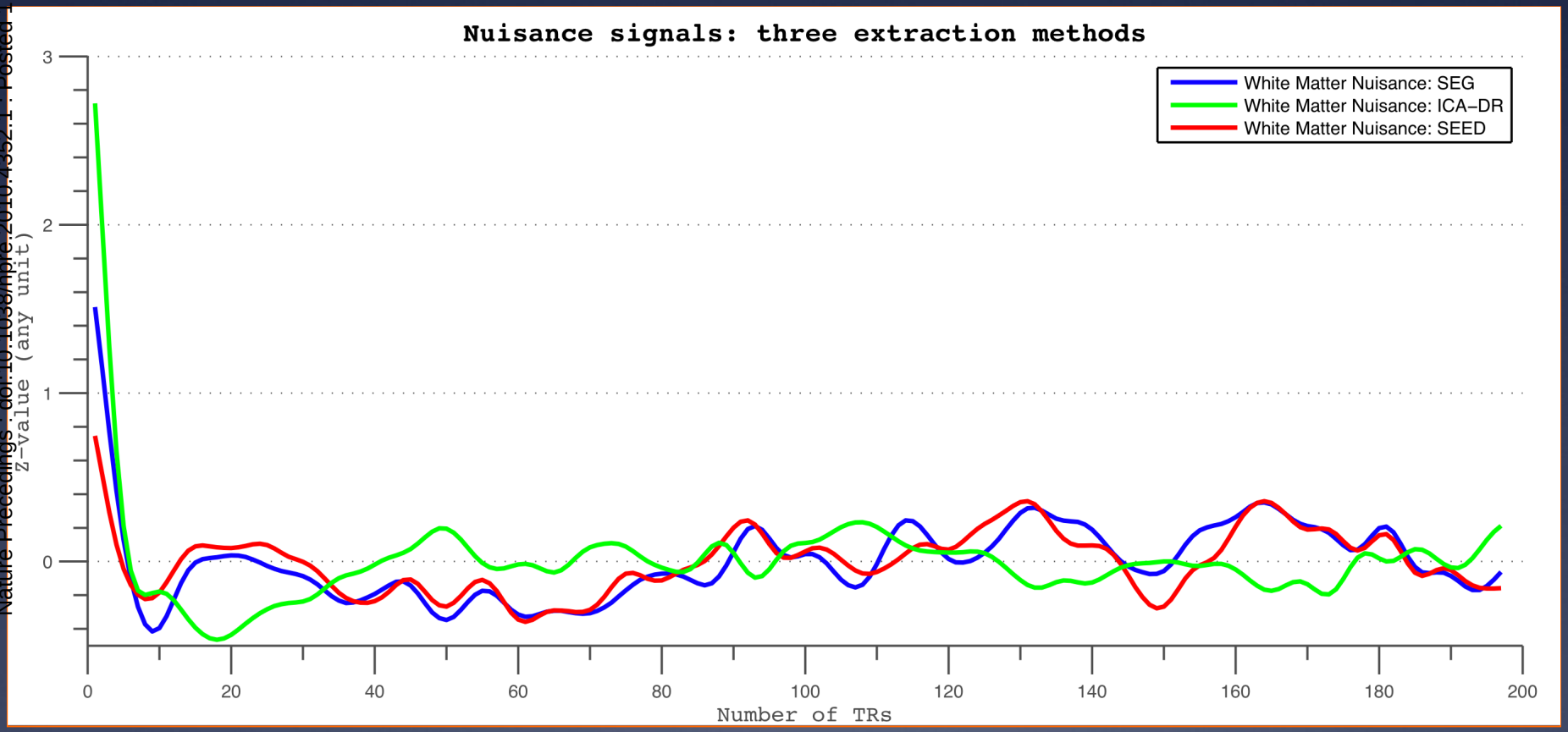
fALFF-Based Gray Matter Mask



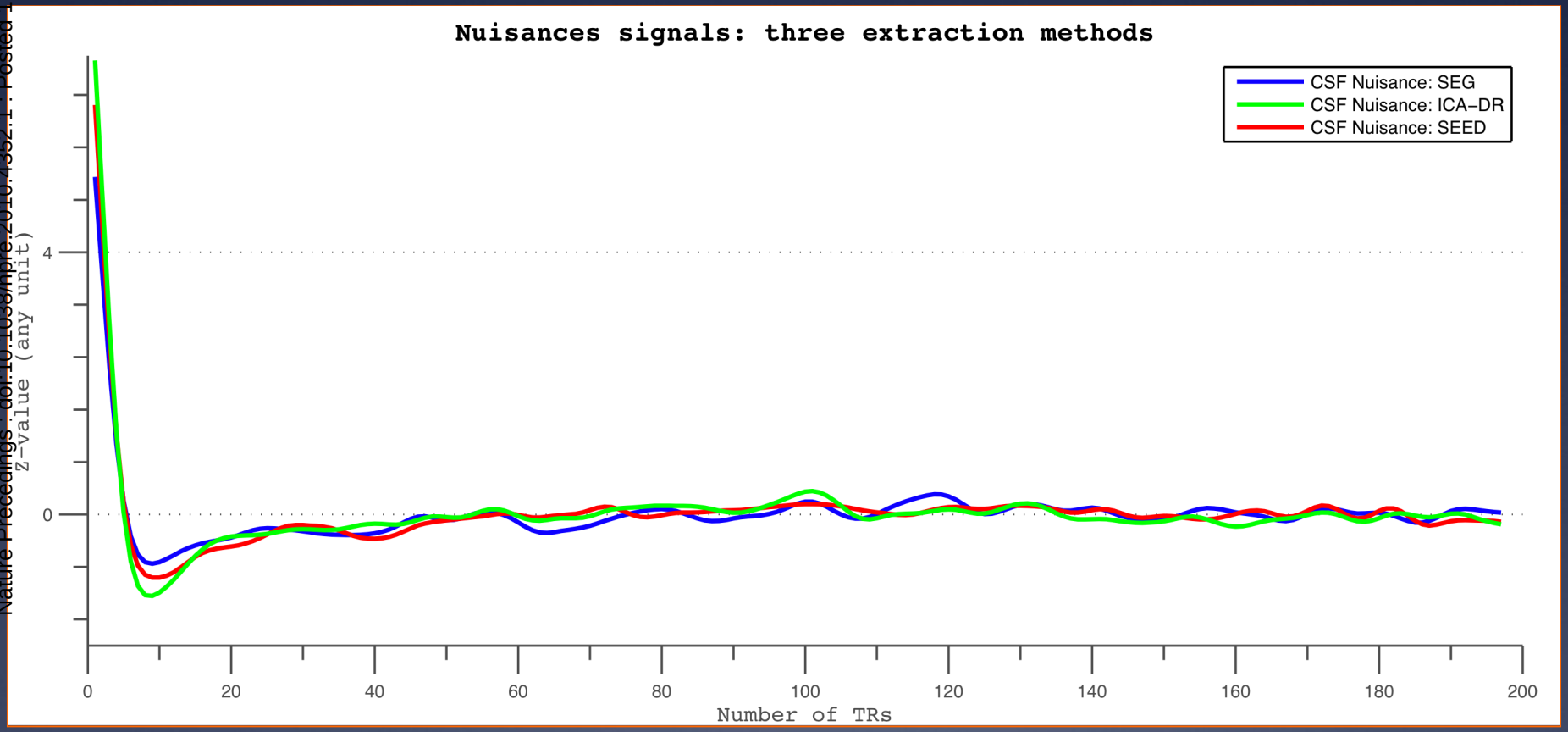
GM-fALFF

Figure 2B in Zuo et al., NeuroImage, 2010.

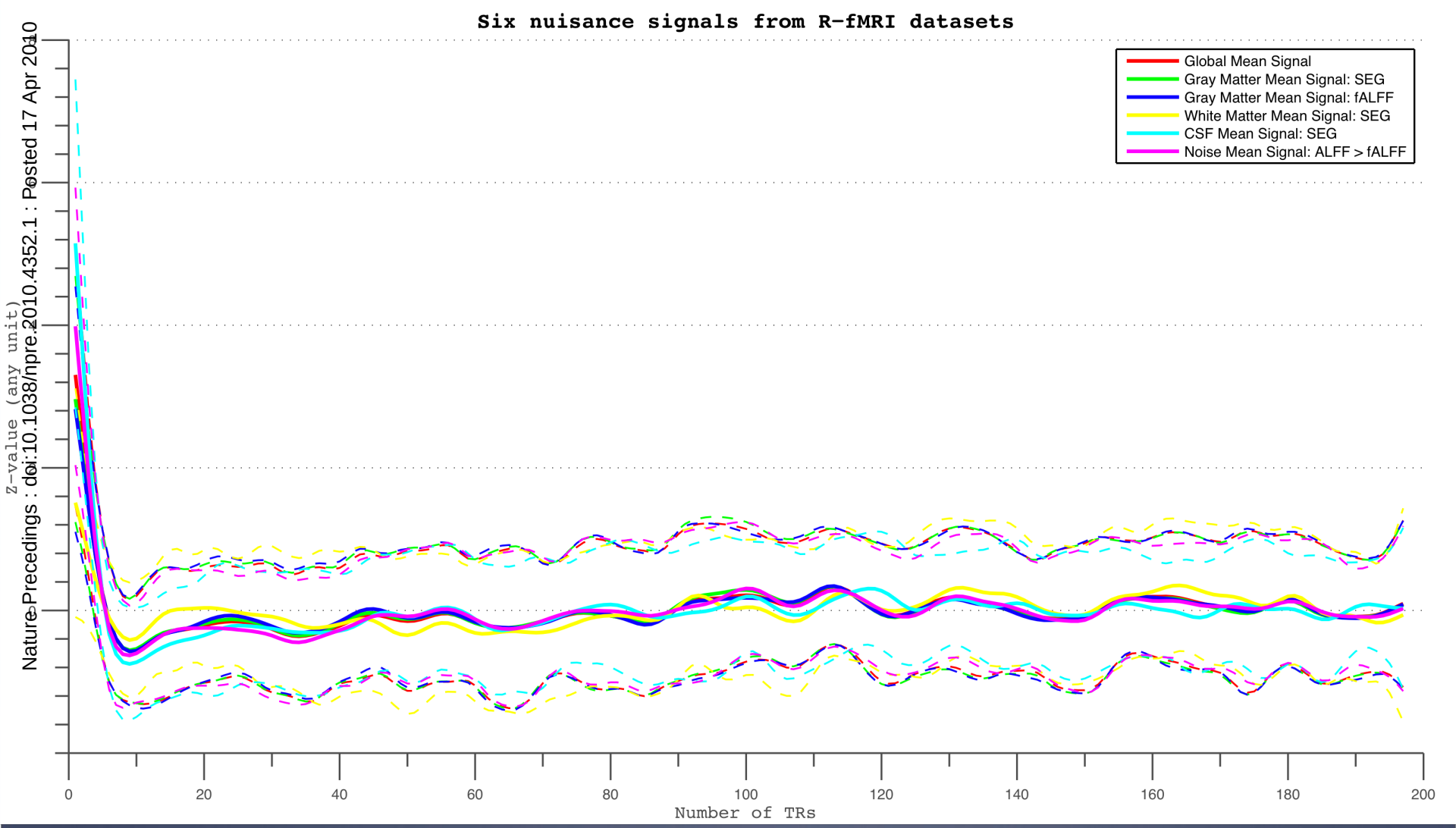
What they look like?



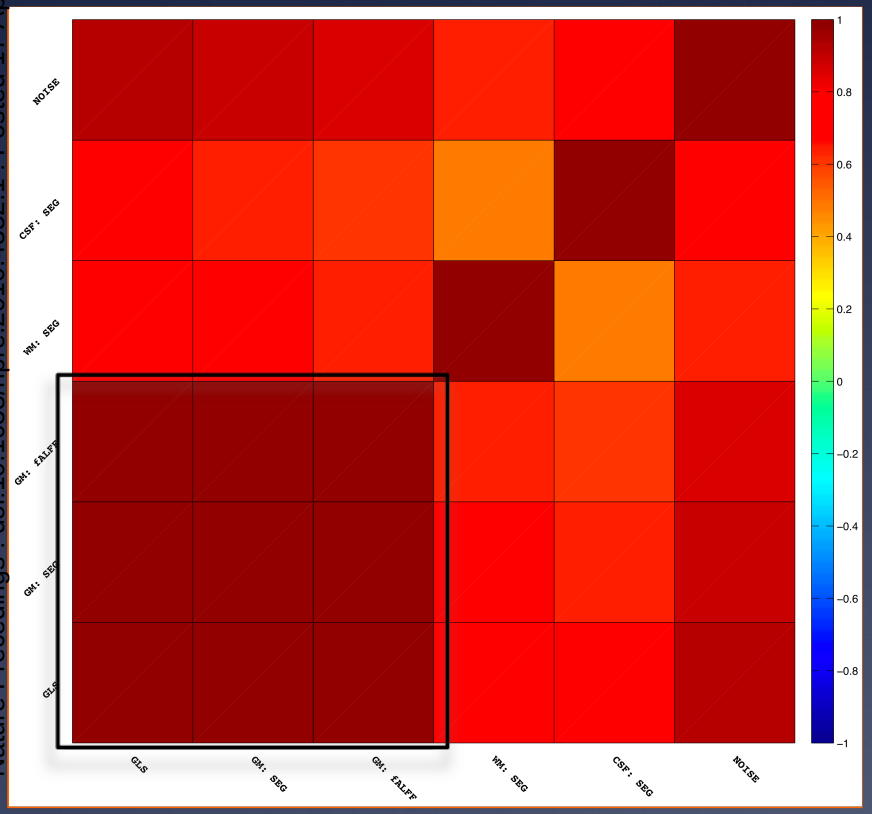
What they look like?



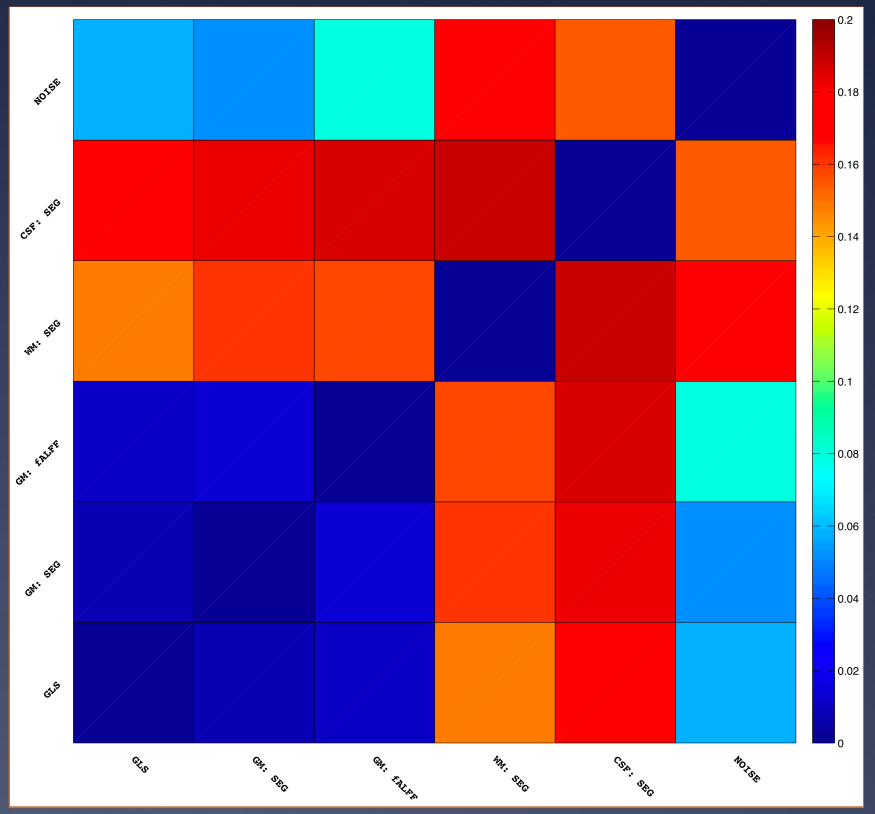
Six Nuisances



Correlation between nuisances

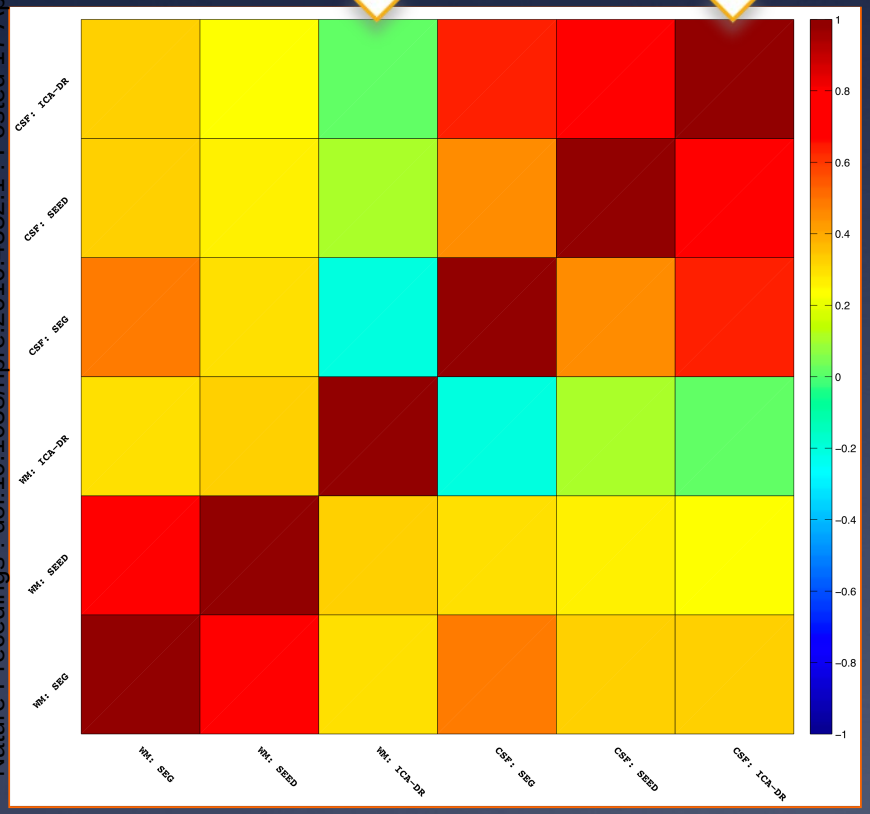


Mean Correlation Across Scans

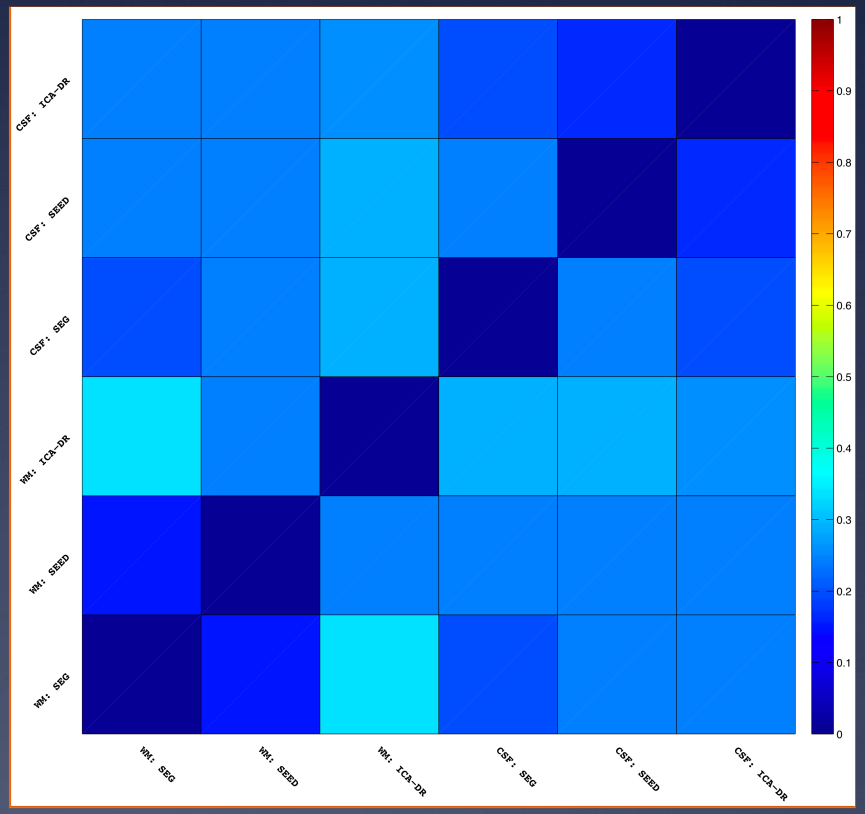


Std (Correlation) Across Scans

Correlation between nuisances

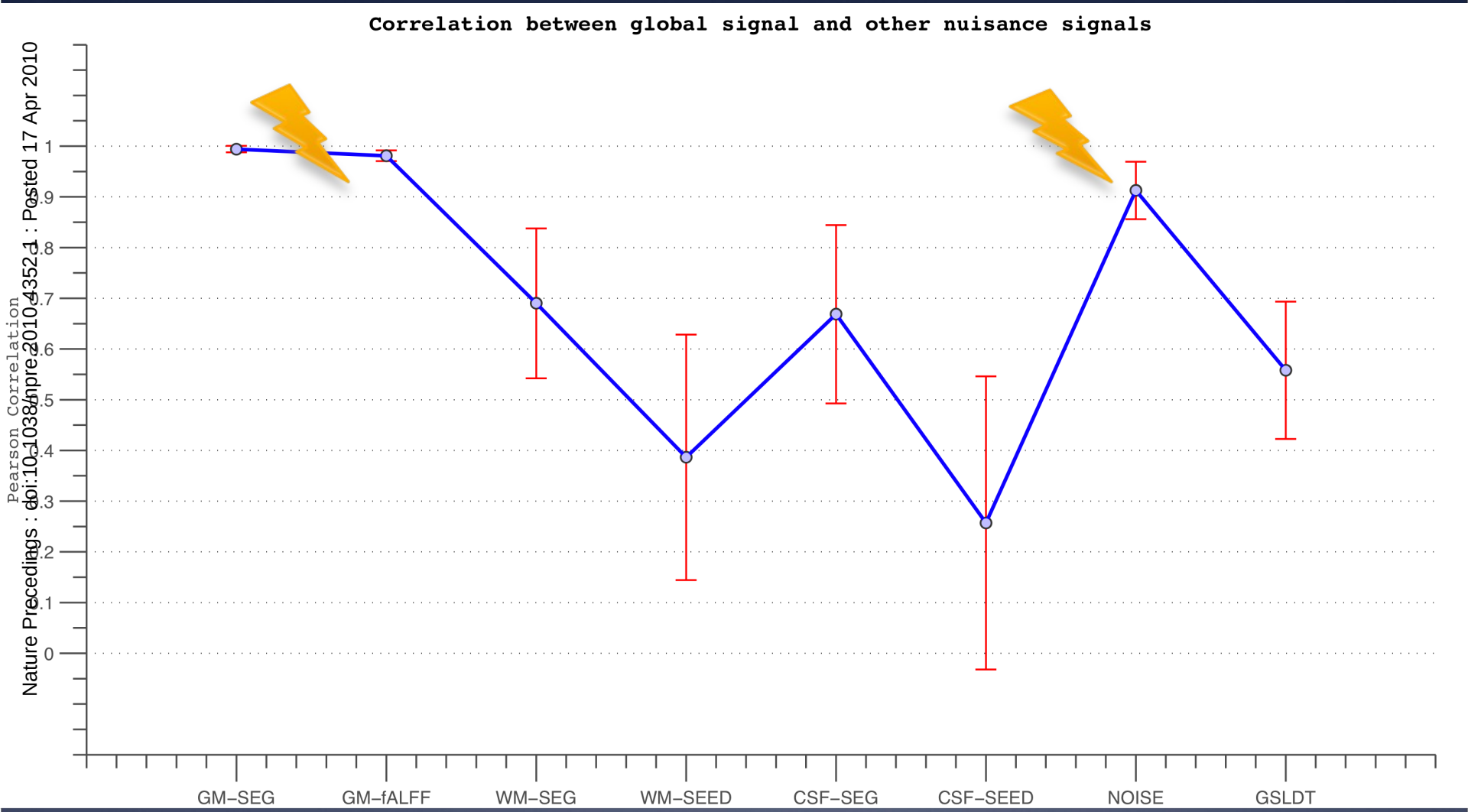


Mean Correlation Across Scans

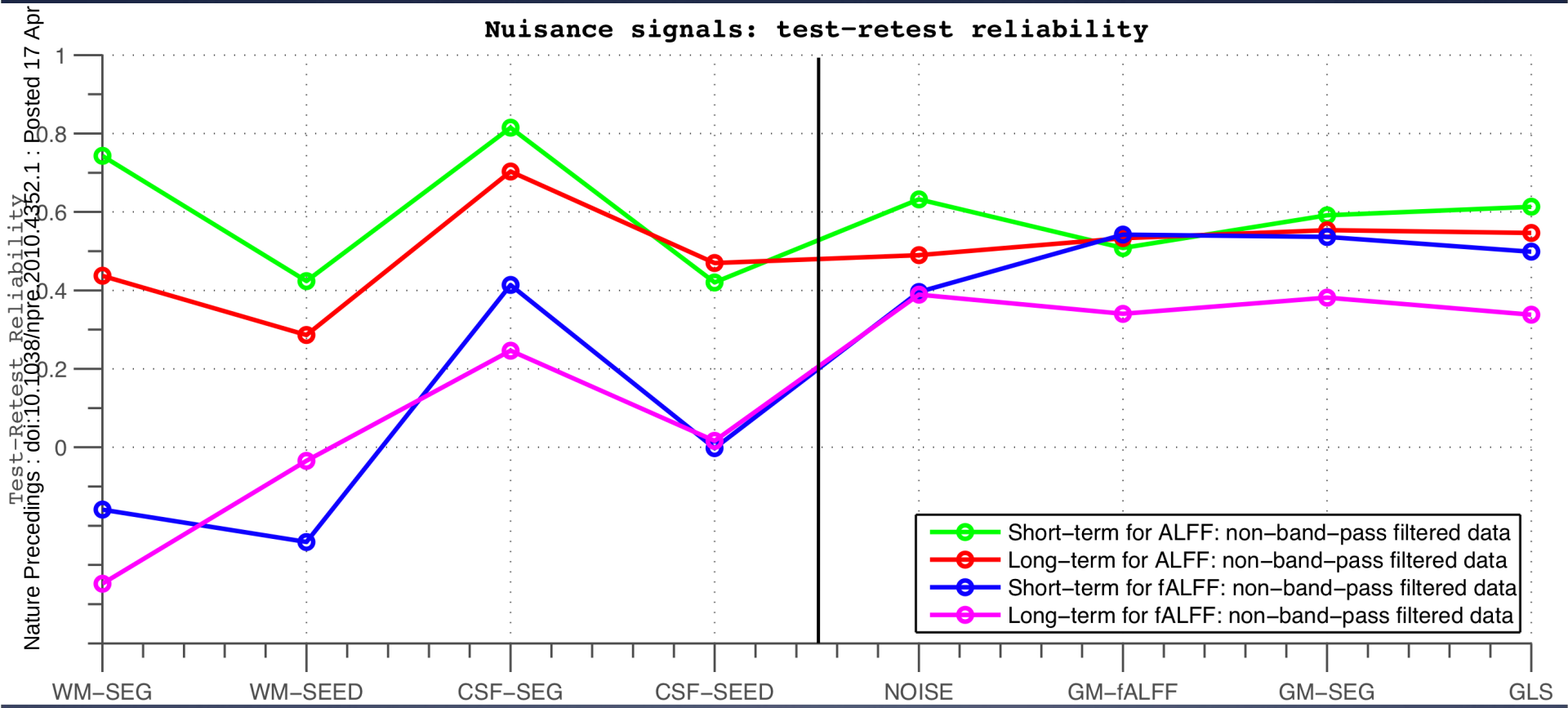


Std (Correlation) Across Scans

Correlation between GLS and other nuisance signals



TRT Reliability



PCC-seeded RSFC

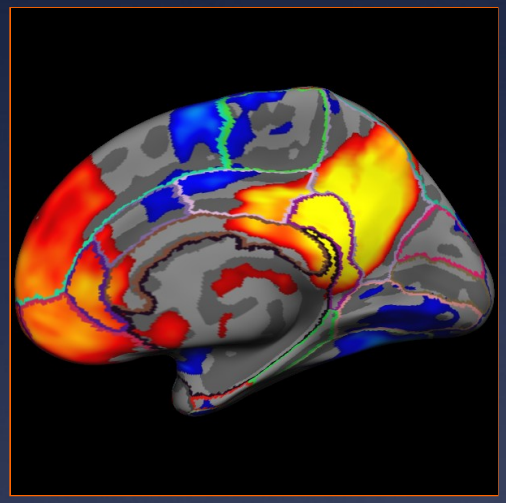
RSFC analyses carried out using PCC as a seed (0, -49, 40).

Prior to RSFC analyses, 6 motion nuisance timeseries are regressed out from preprocessed data.

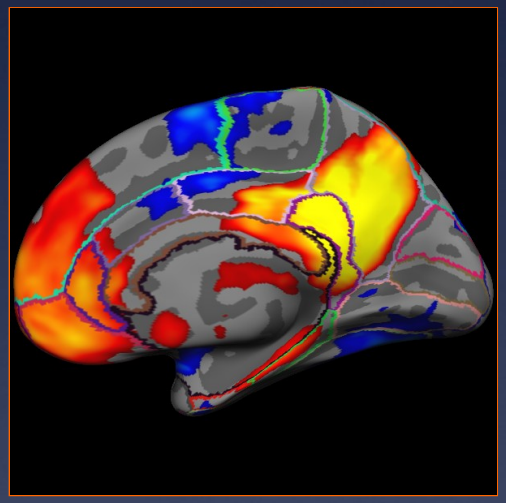
Several different strategies for removing artifactual signals beyond motion were employed.

We assess similarity and differences between resulting maps, as well, reliability of different solutions.

RSFC: with global signal regression



SEGMENT



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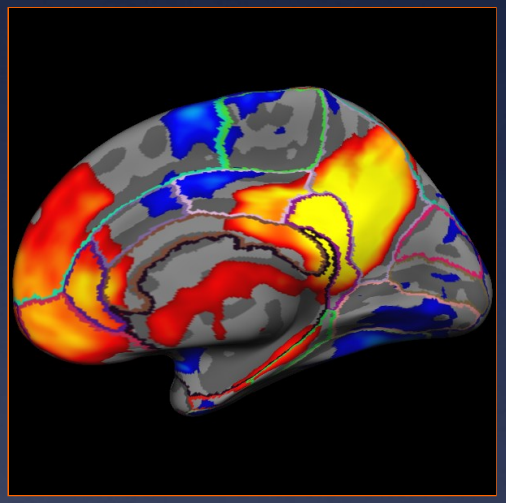
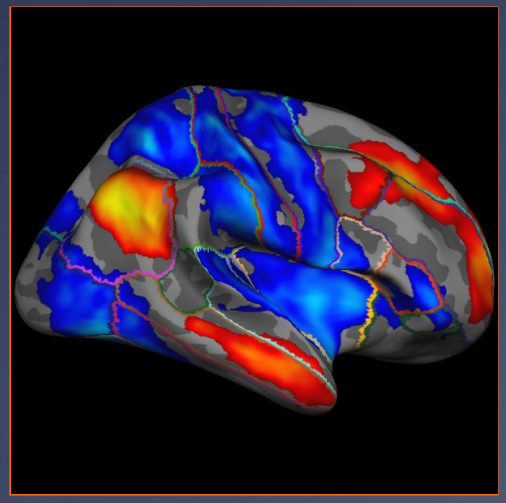
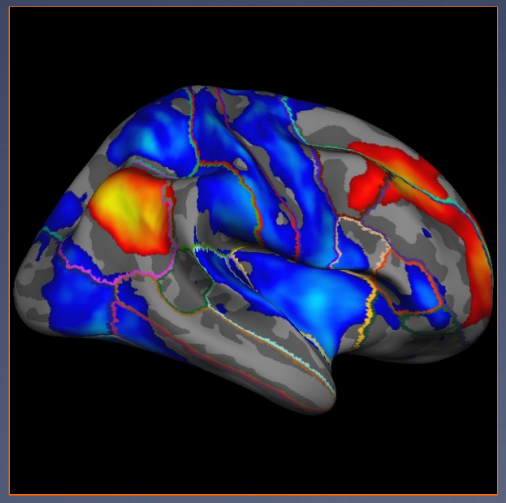
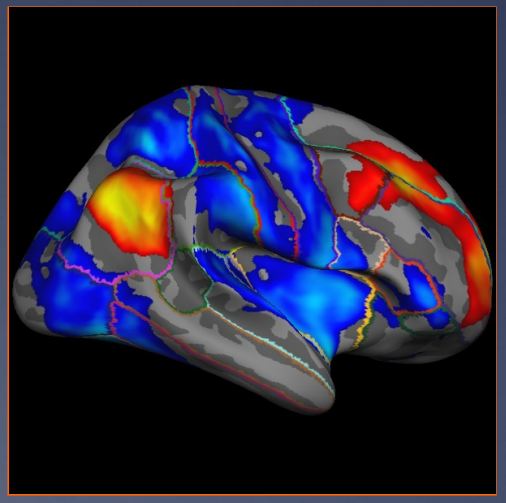


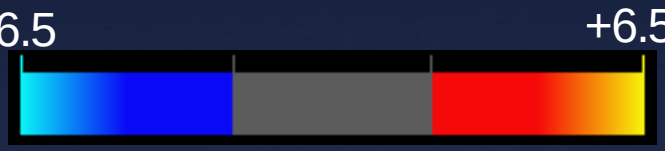
ICA-DR

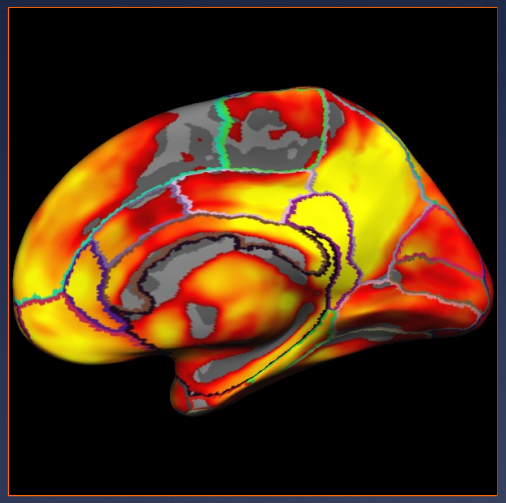






RSFC: without global signal regression





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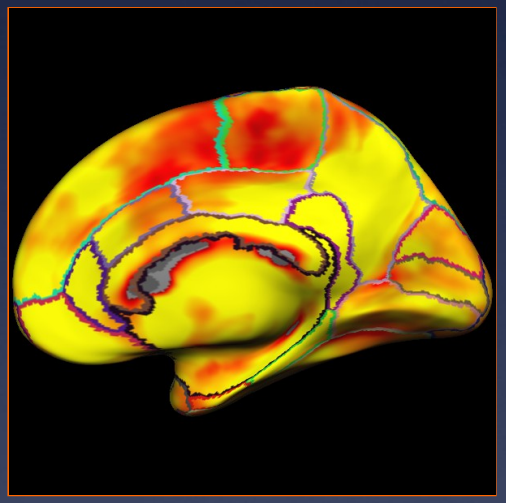

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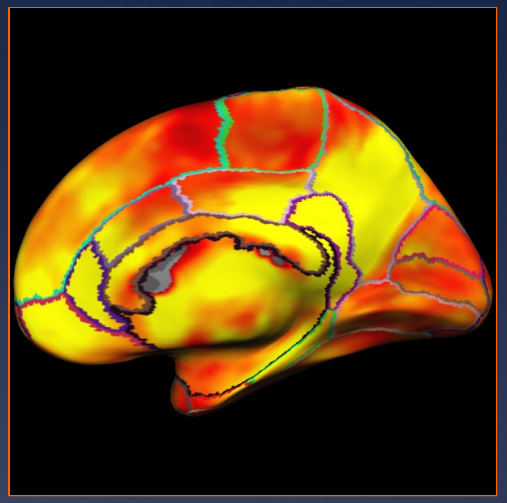

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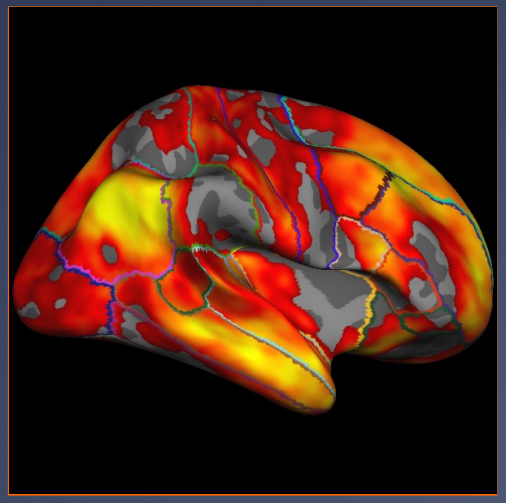
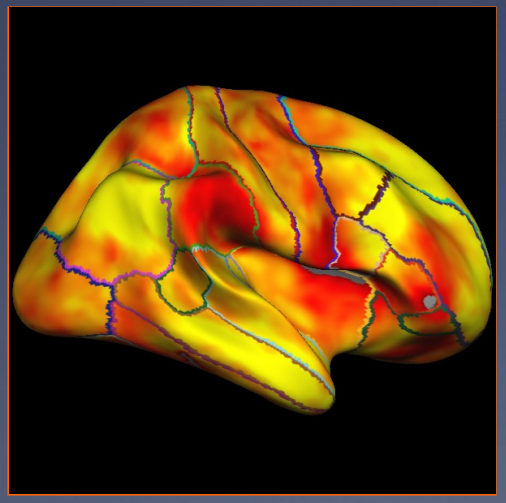
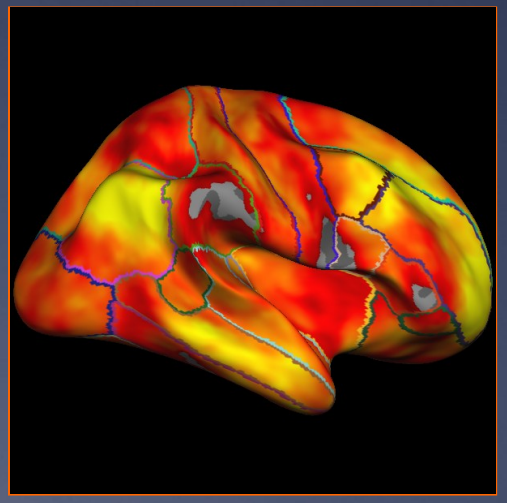
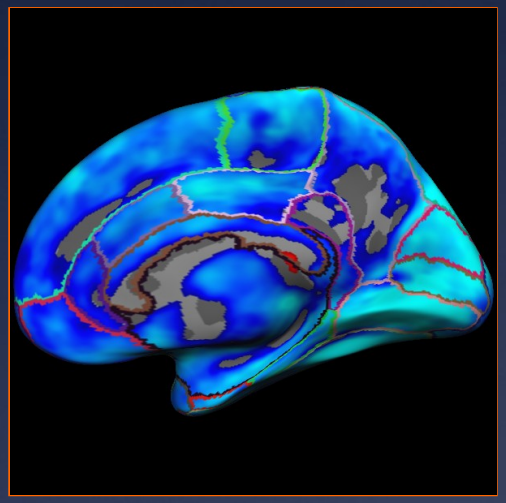






RSFC: with gsr versus without gsr



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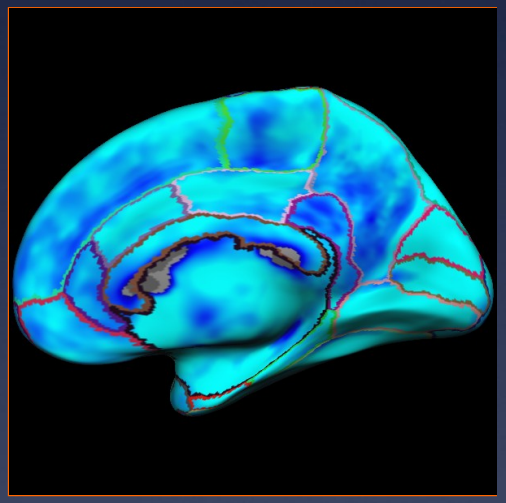

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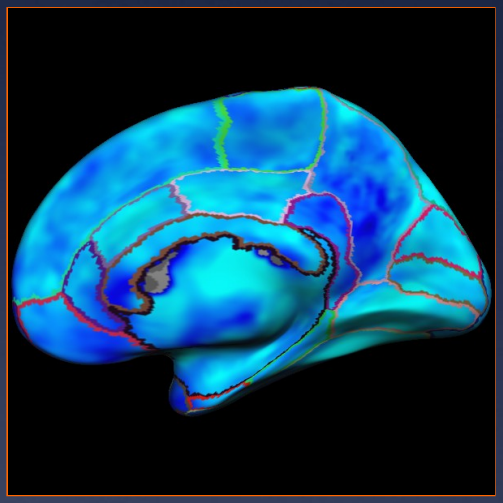

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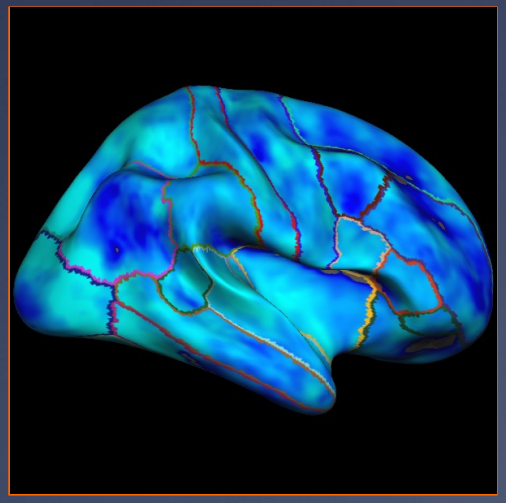
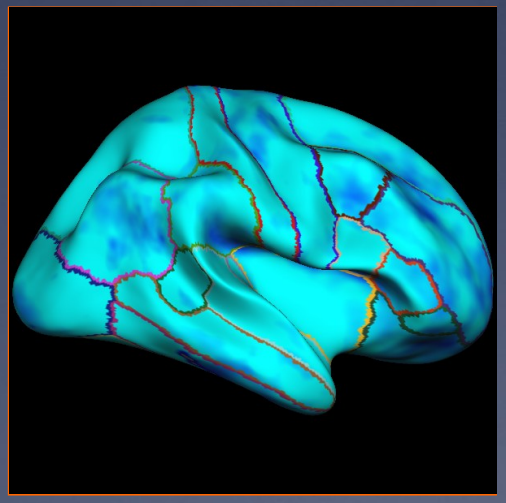
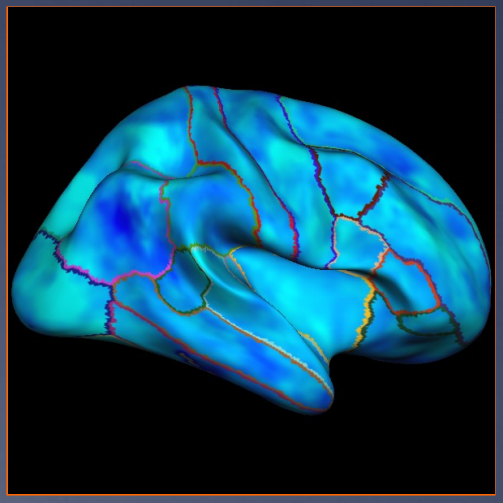
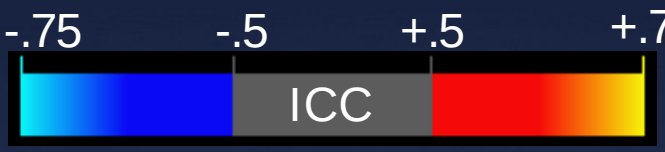
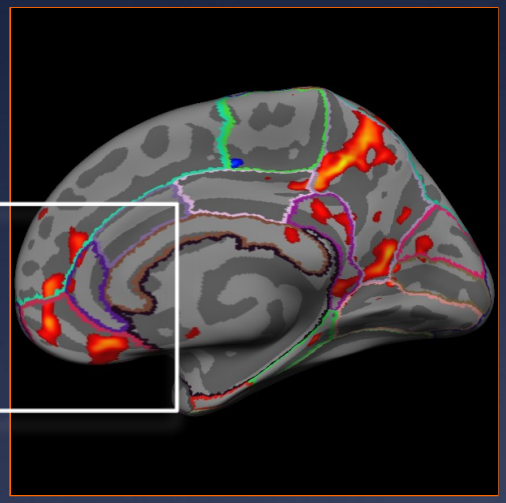


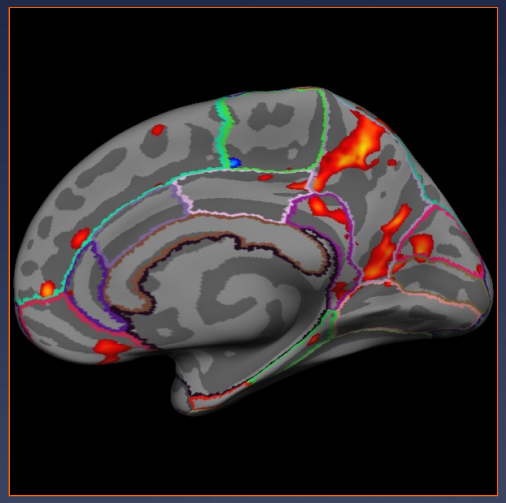


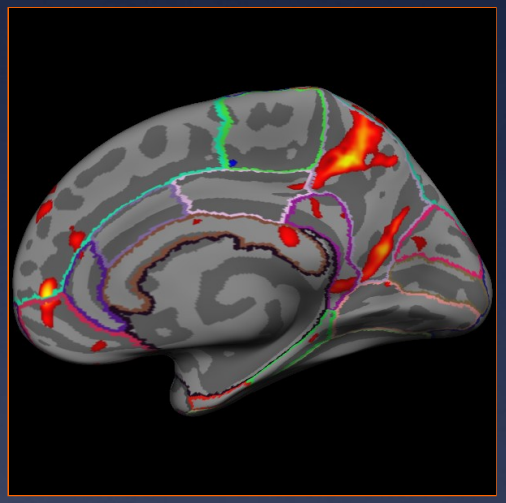


Reliability: with global signal regression









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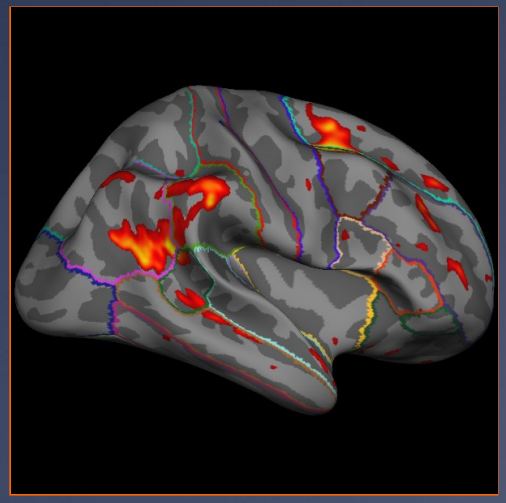
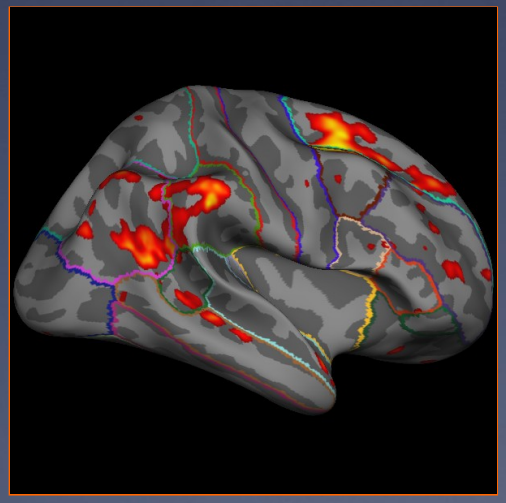
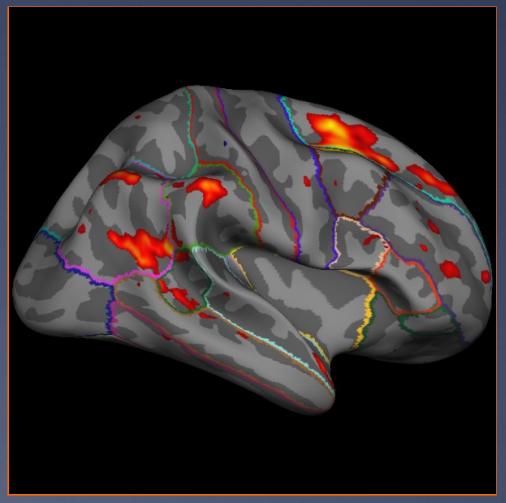
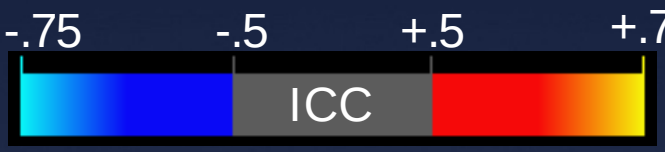
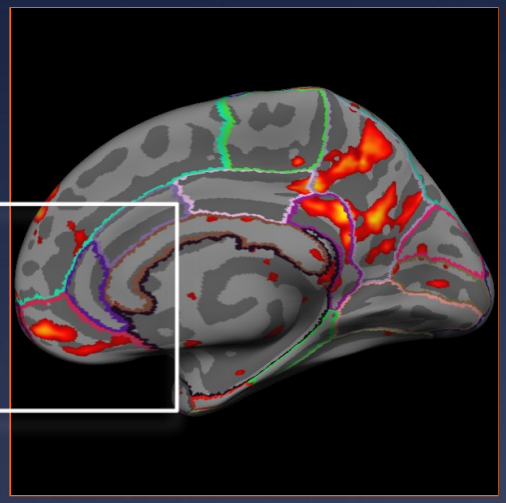


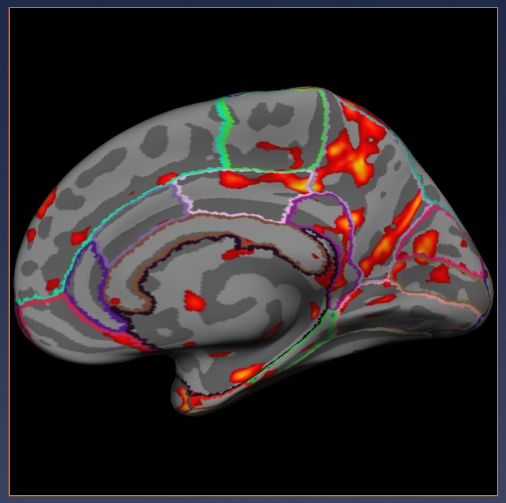


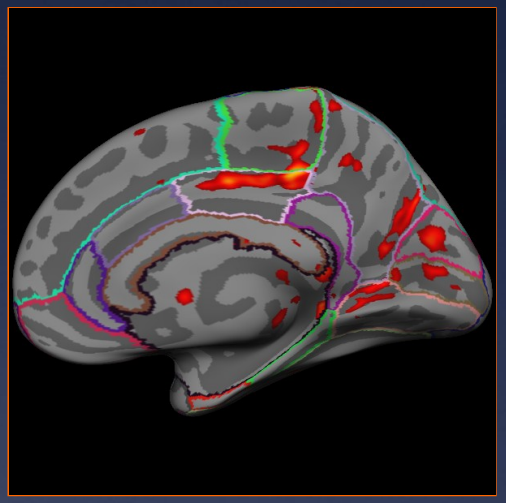


Reliability: without global signal regression





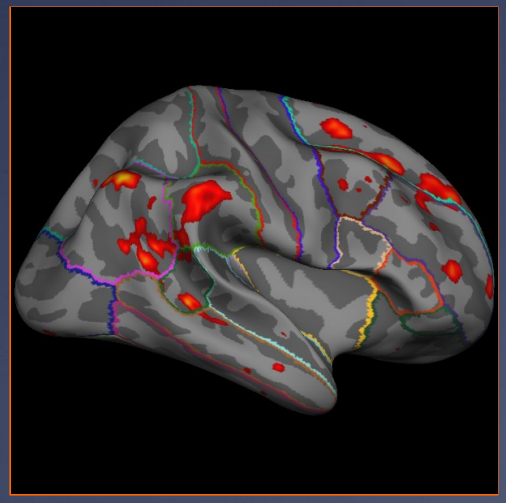


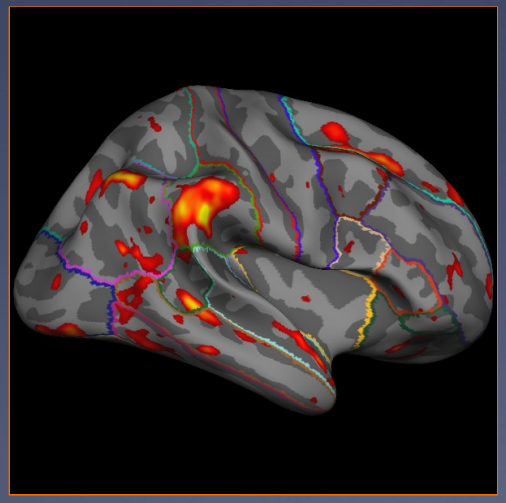


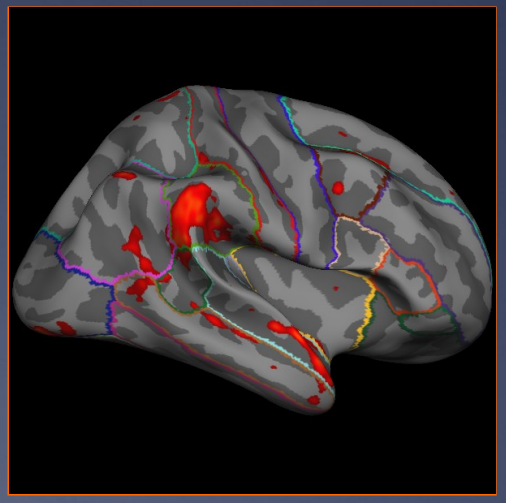
SEGMENT

SEED

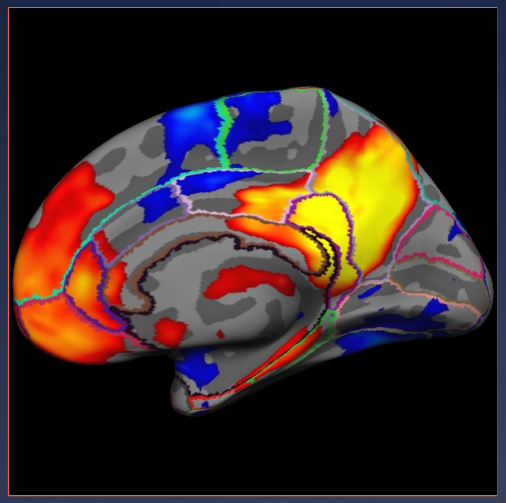
ICA-DR



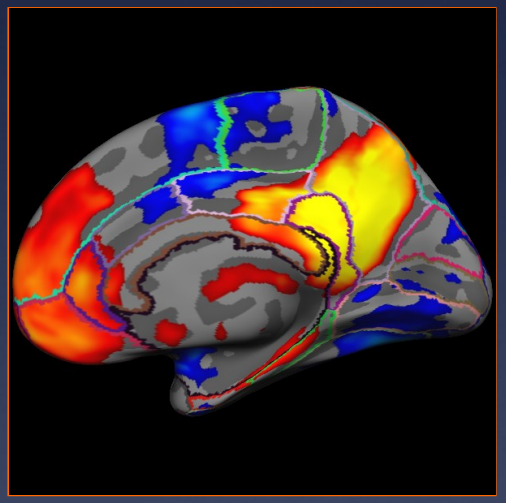




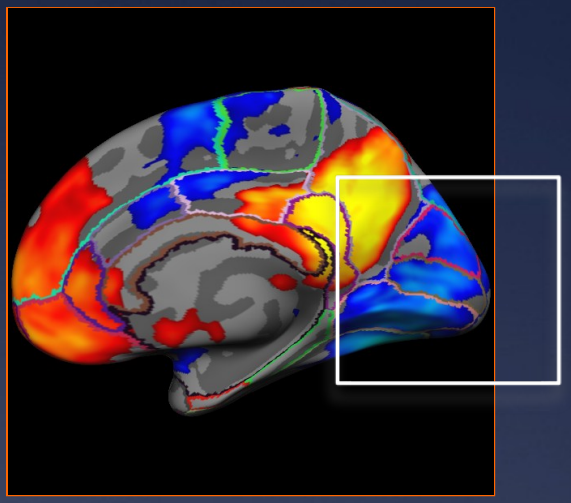
RSFC: effects of GM-related nuisance regression



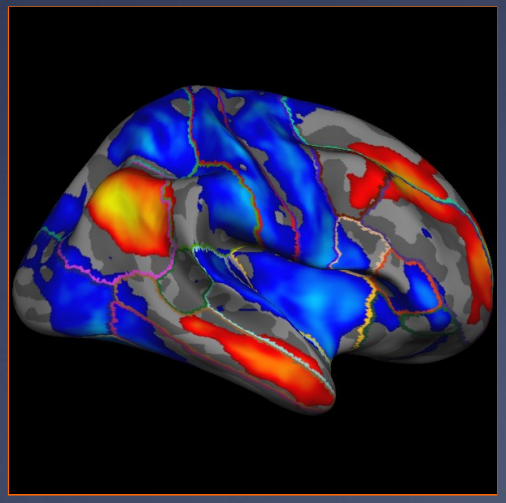
GLR

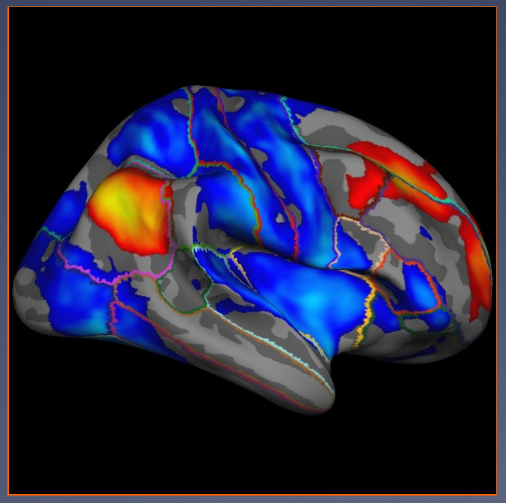


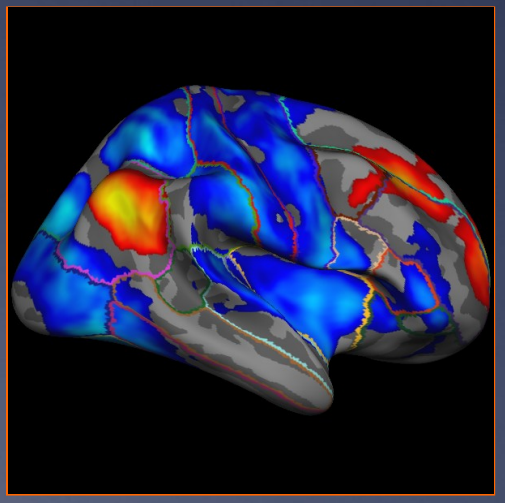
GMR: SEG



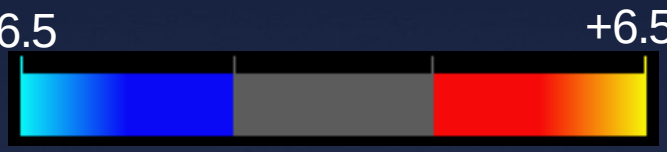
GMR: fALFF

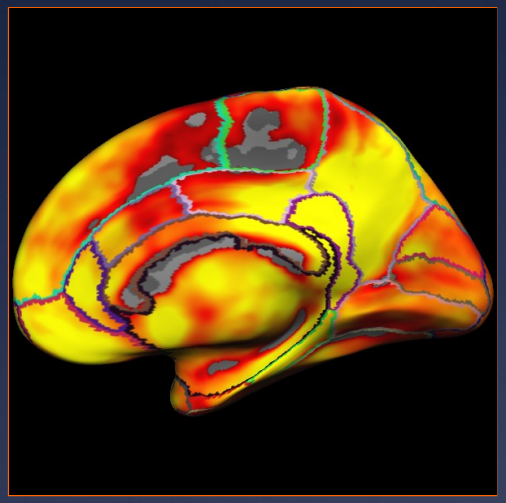




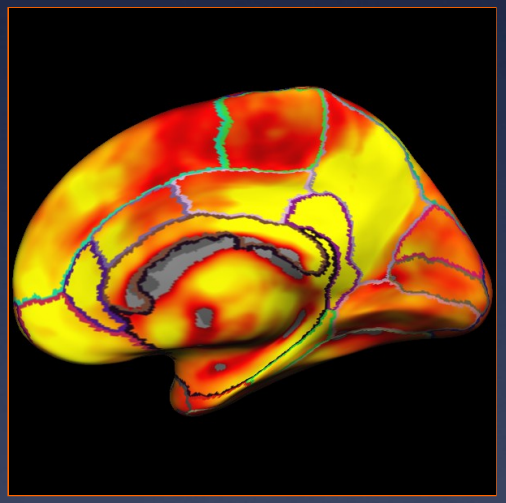


RSFC: effects of non-GM-related nuisance regression

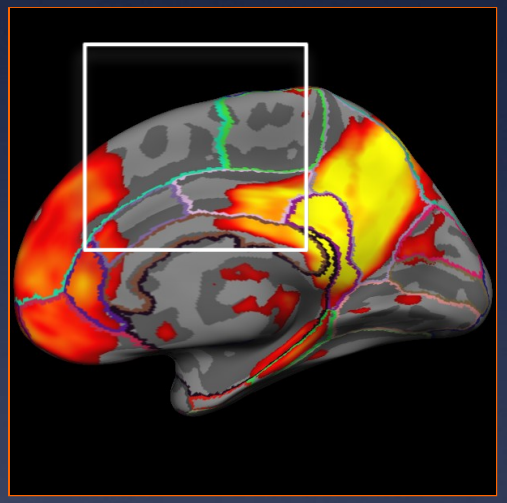




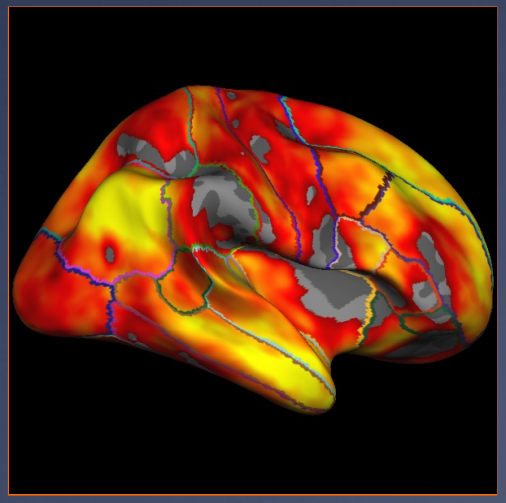
WM: SEG

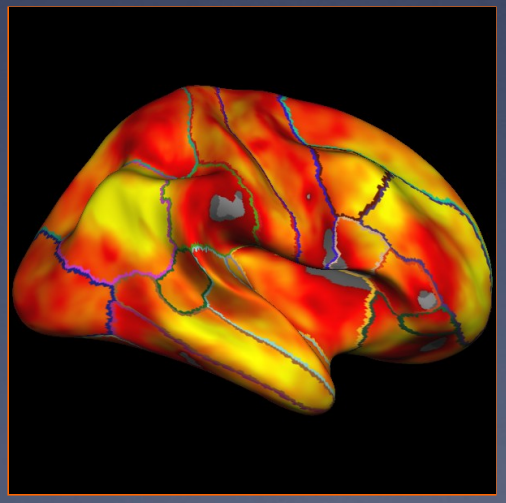


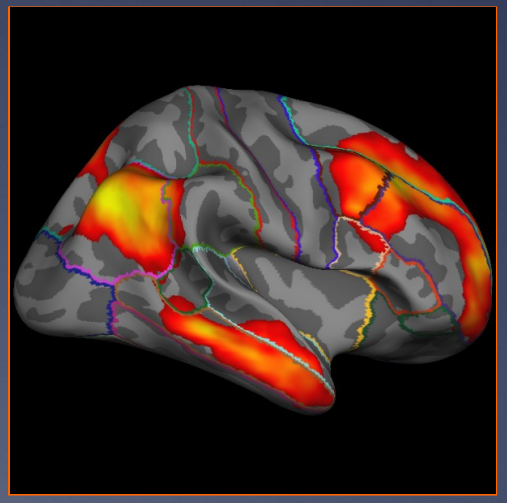
CSF: SEG



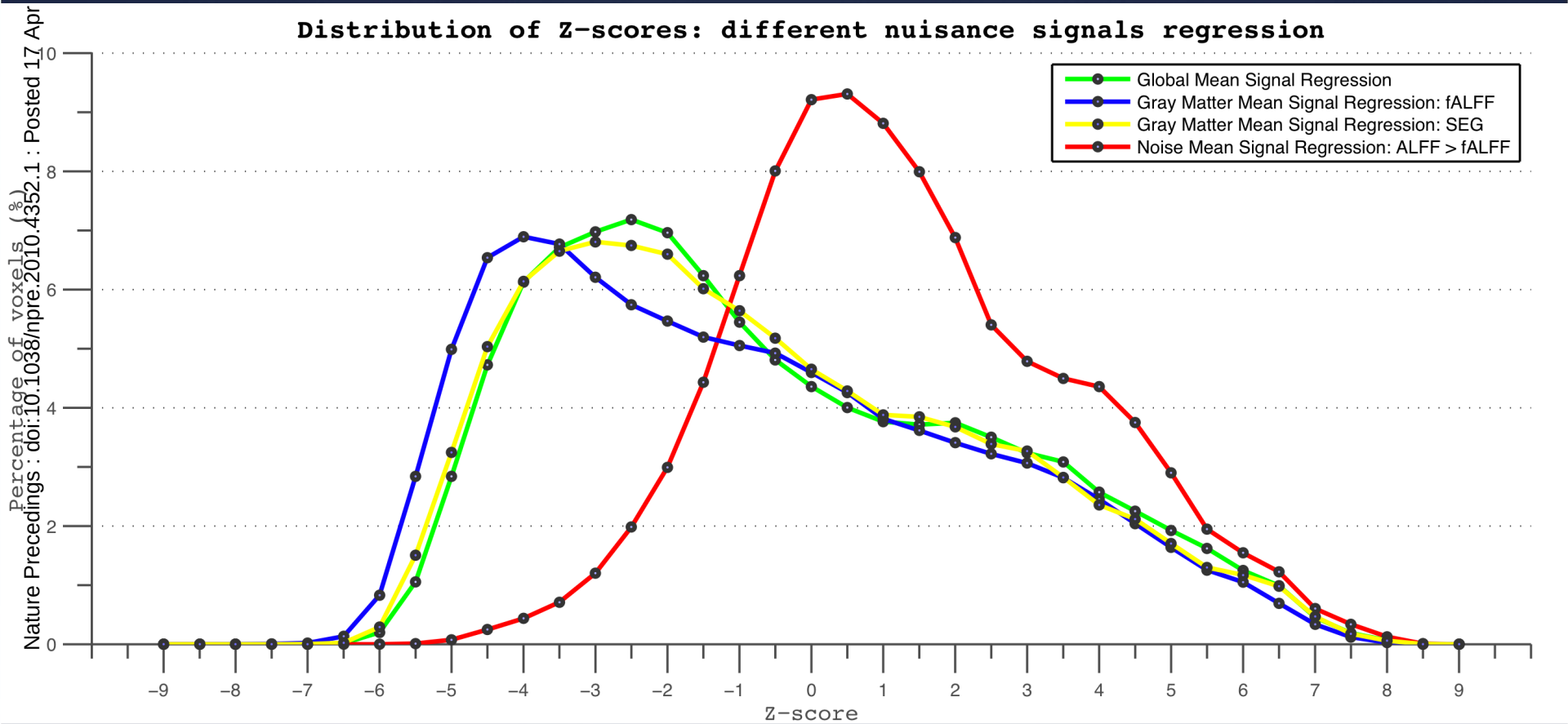
NOISE: fALFF



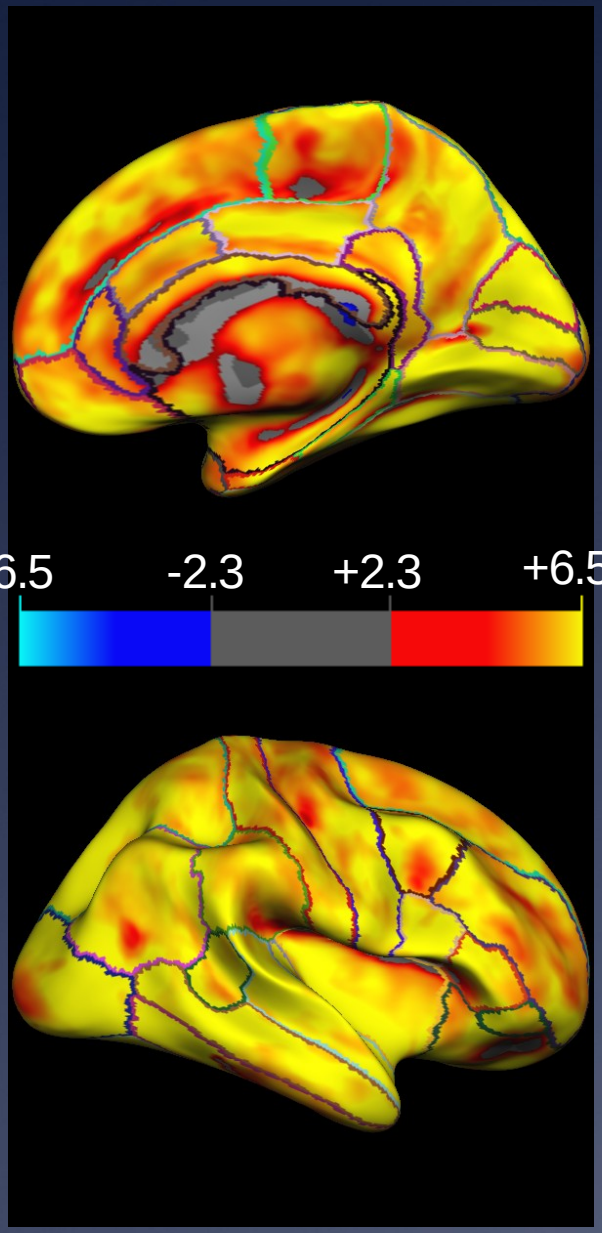


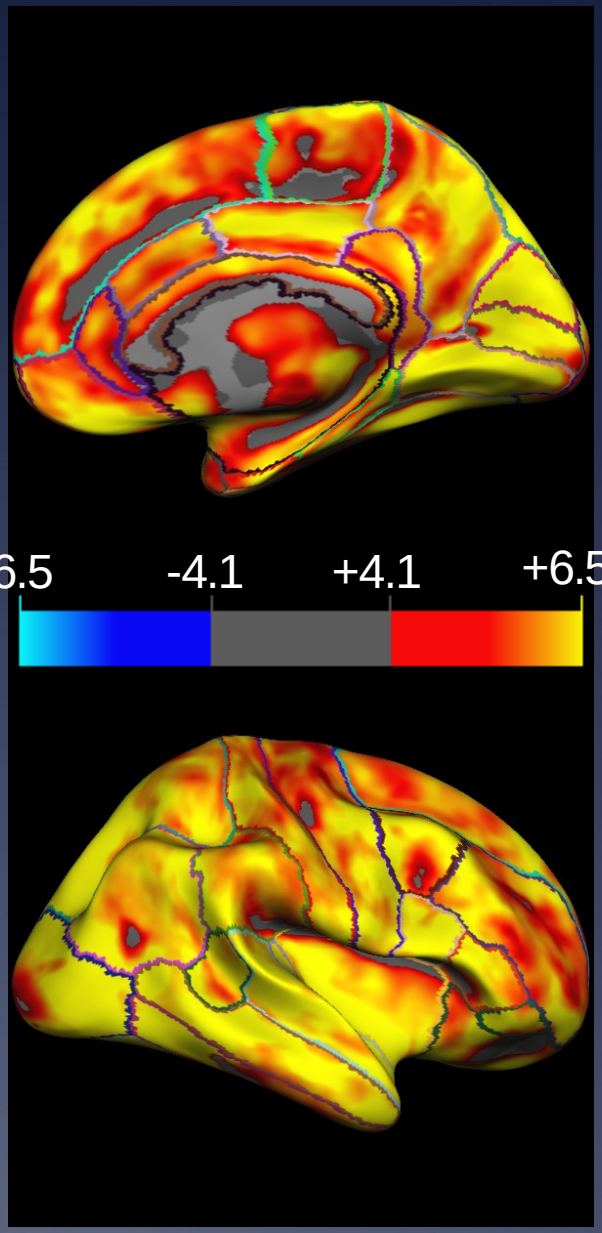


RSFC: effects of NOSIE nuisance regression

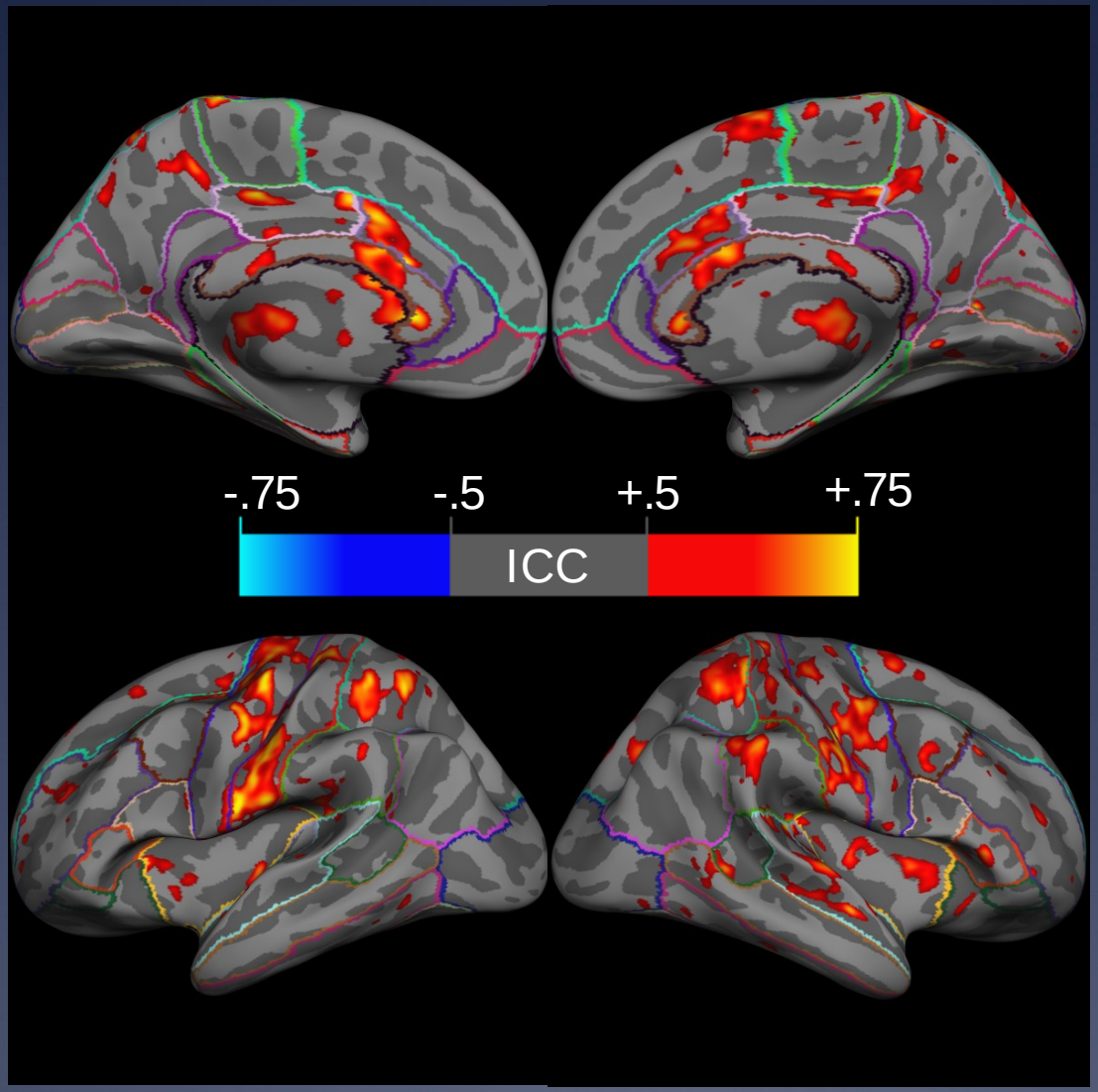


RSFC of global signal after removal of WM and CSF (GLSDT)

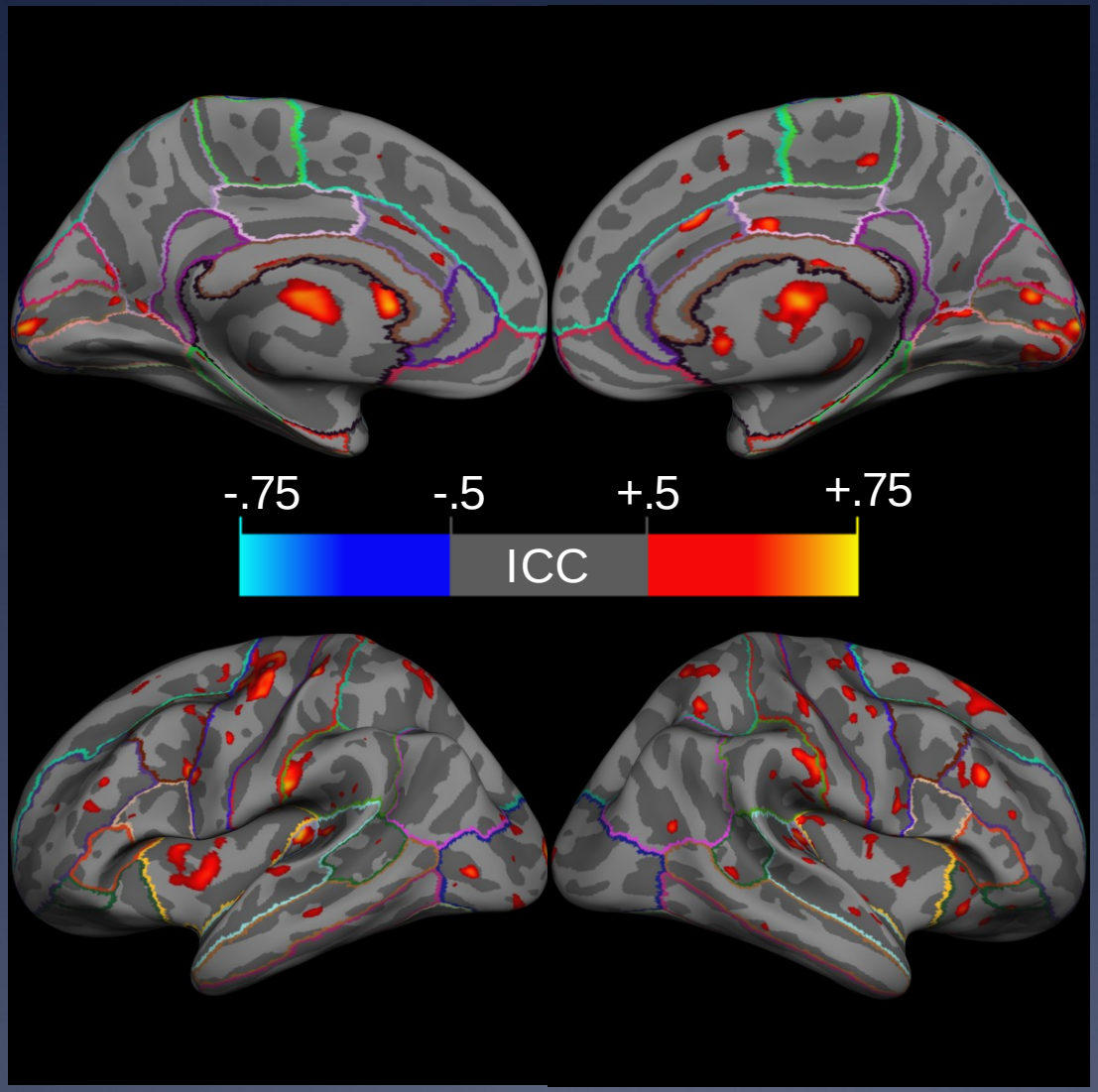




Short-term Reliability
RSFC of GLSDT nuisance signal



Long-term Reliability
RSFC of GLSDT nuisance signal



Further thoughts: ICA-based de-noise

Scan-level ICA: 75 single ICA runs.

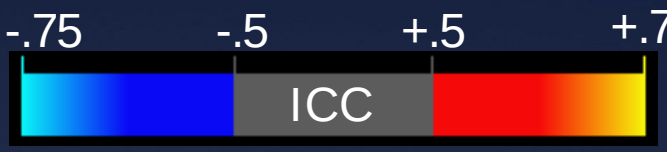
Noise features: 1). Tissue probability; 2). NOISE correlation; 3). Head motion regression.

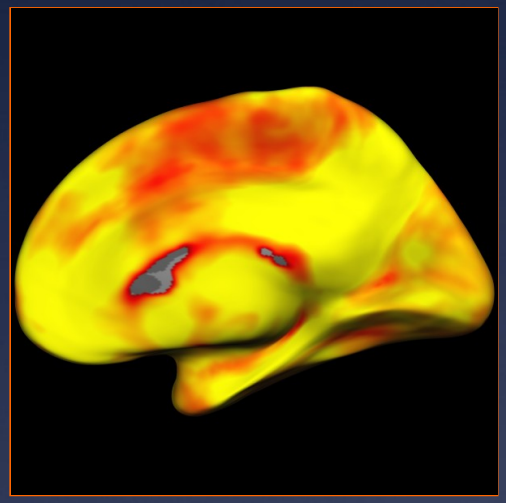
Semi-automated methods: need your mouse clicks

The noise components look scaring

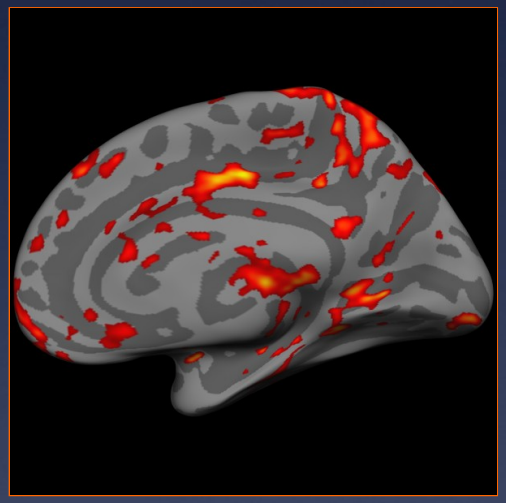
Will see the reliability of RSFC based on the two different de-noise approaches.

ICA de-noise: RSFC and Reliability

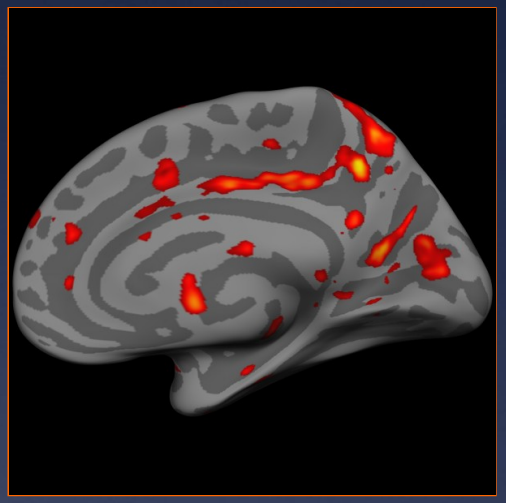




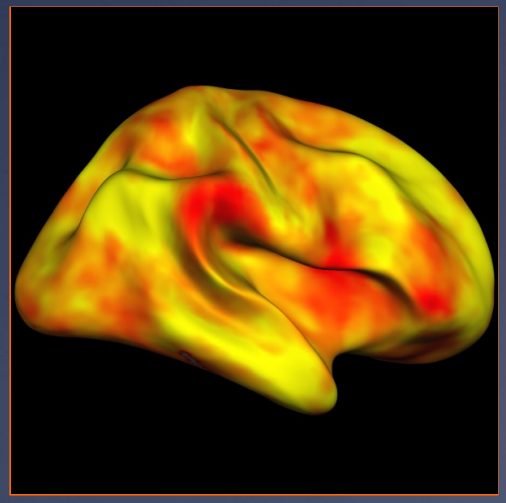
RSFC

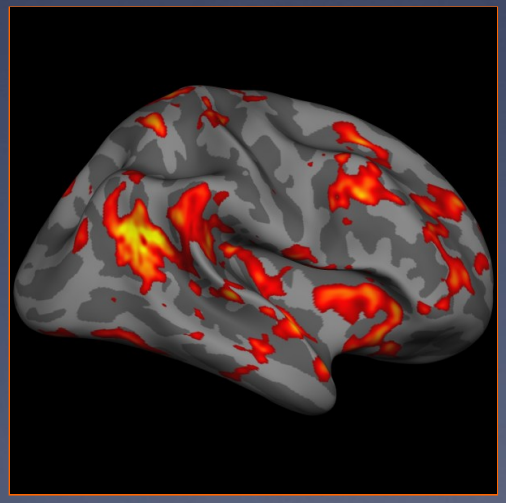


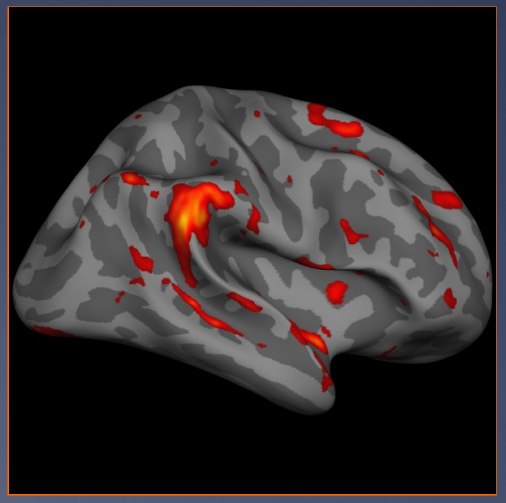
ICC1



ICC2







Thank Team Family