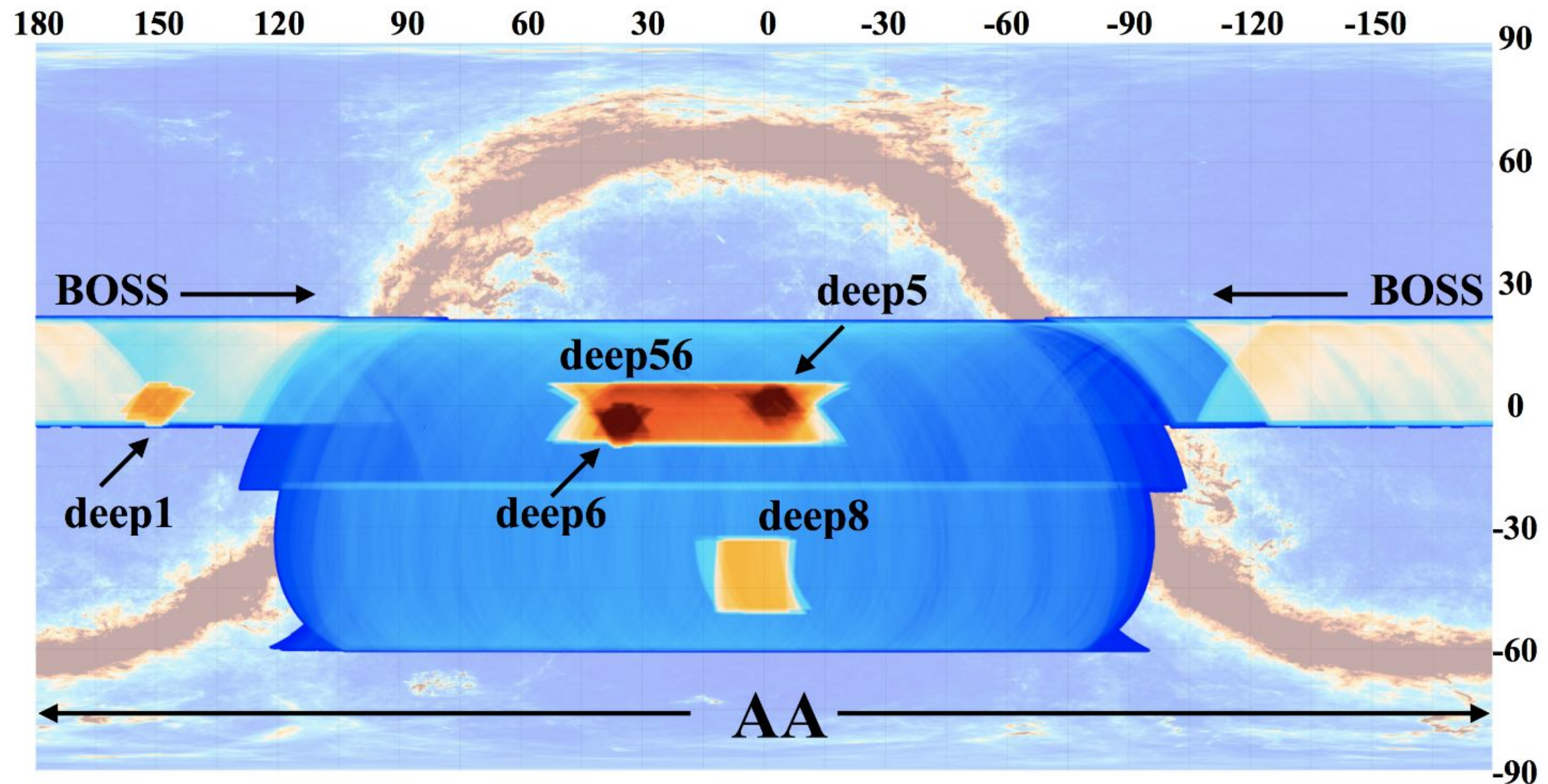


ACTPol lensing maps and foreground-cleaned galaxy correlations

with Matthew Madhavacheril, Blake Sherwin,
and the ACT Collaboration

**STFC-CDT
Funding**

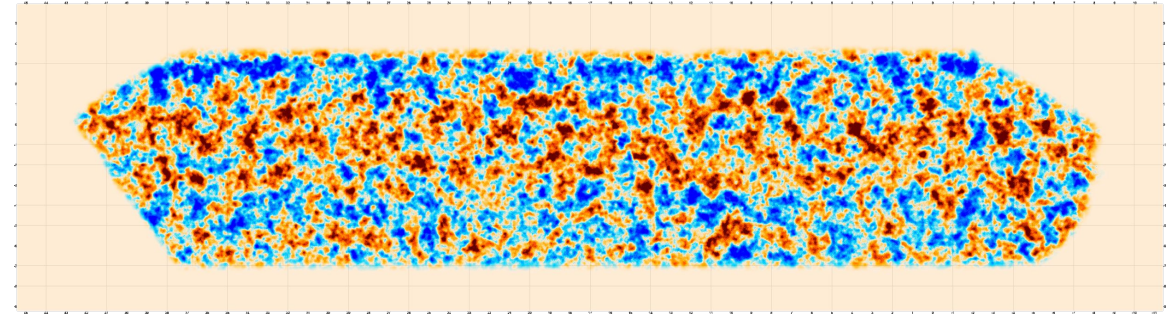
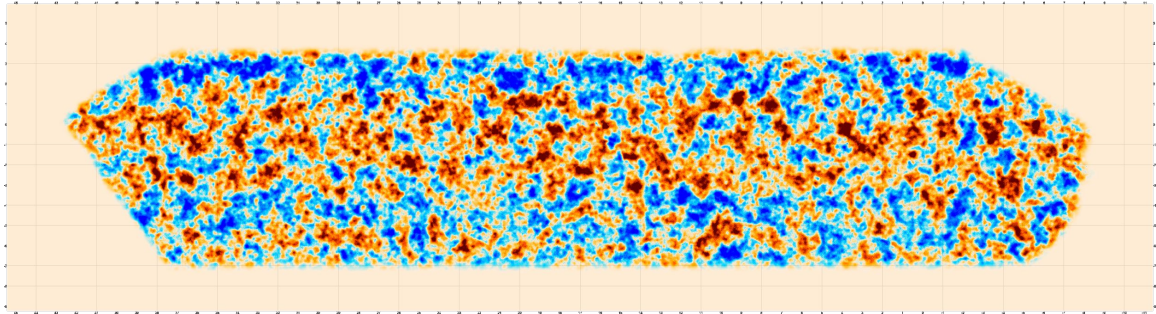
ACT Experiment



Credits: Simone Aiola

- Effective area BOSS+Deep56 ~ 2100 sq deg
- Overlap with multiple surveys! (BOSS, DES,...)

CMB Lensing from ACT



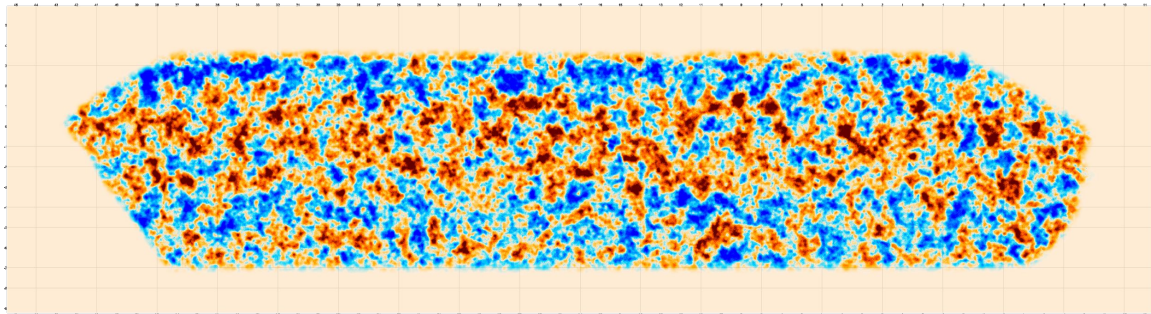
Non Gradient
Leg

Gradient Leg

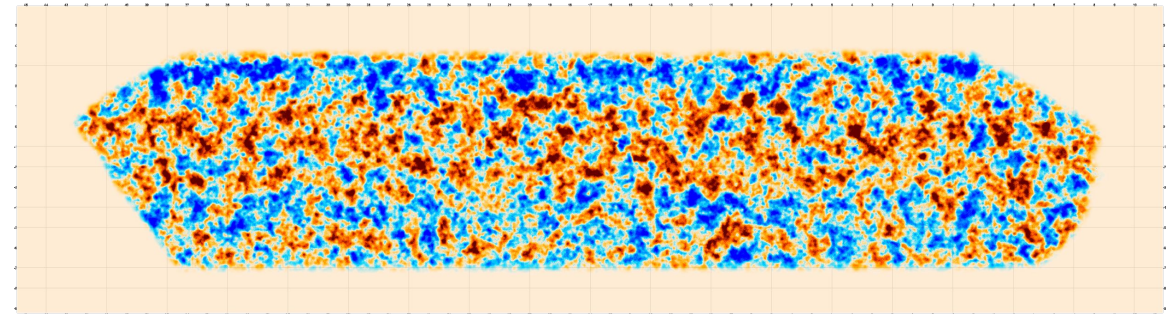
$$\kappa \sim \nabla \cdot (T \nabla T)$$

CMB Lensing from ACT

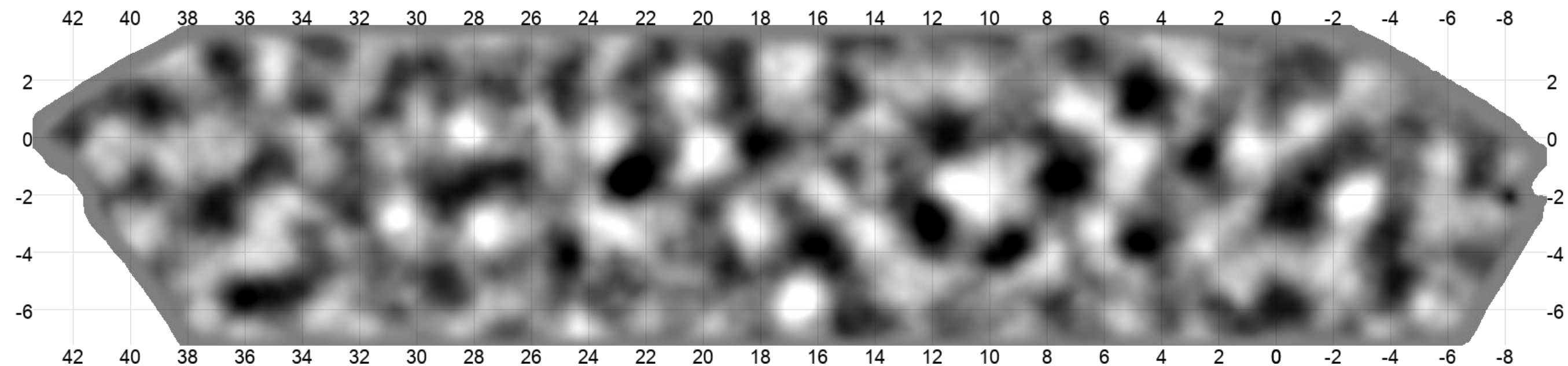
Non Gradient Leg



Gradient Leg

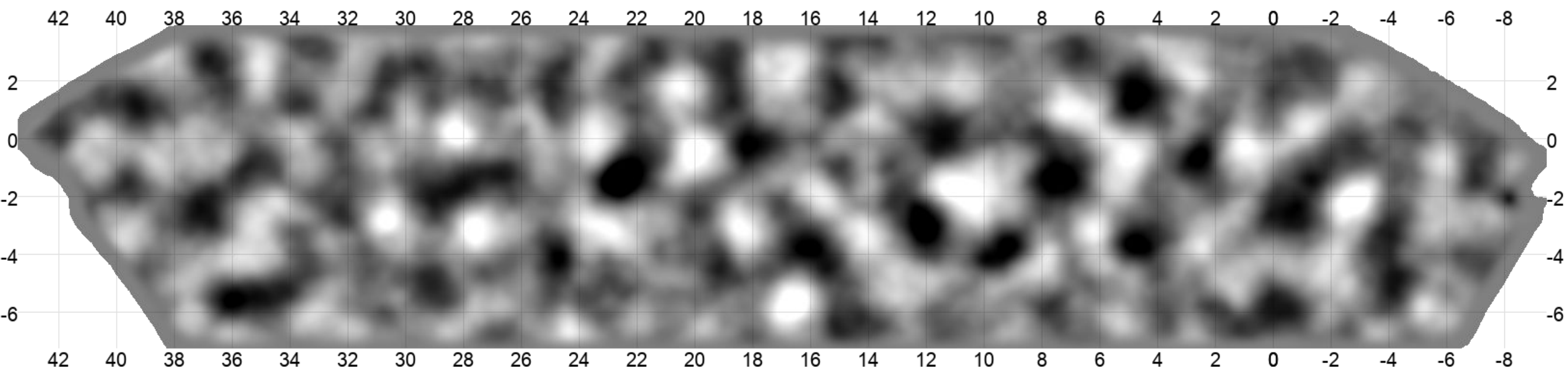
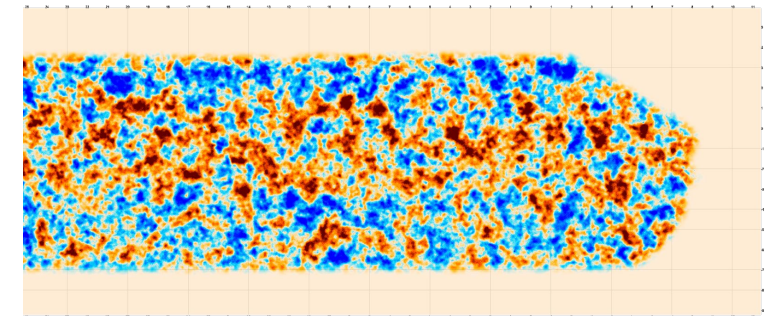
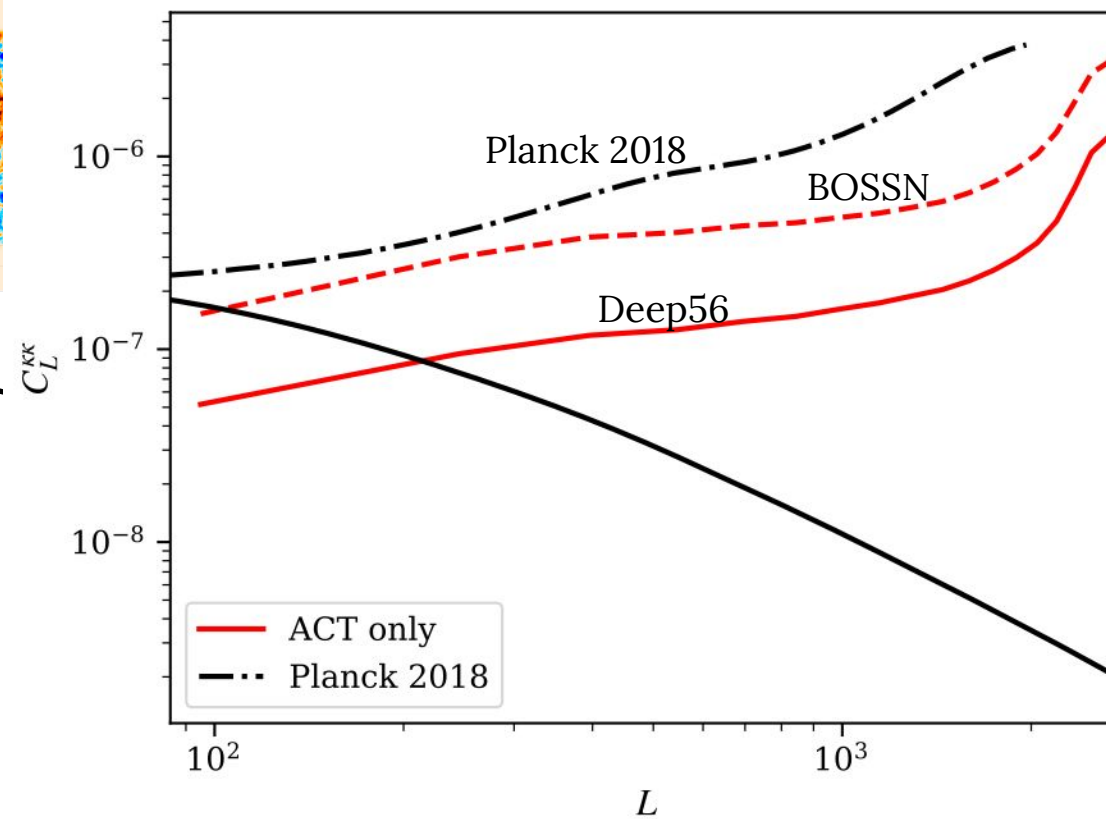
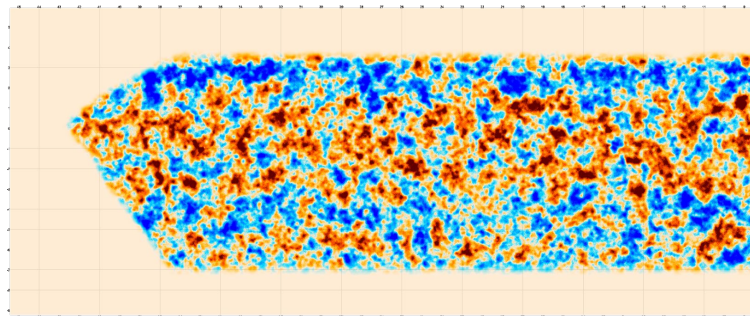


Quadratic
Estimator



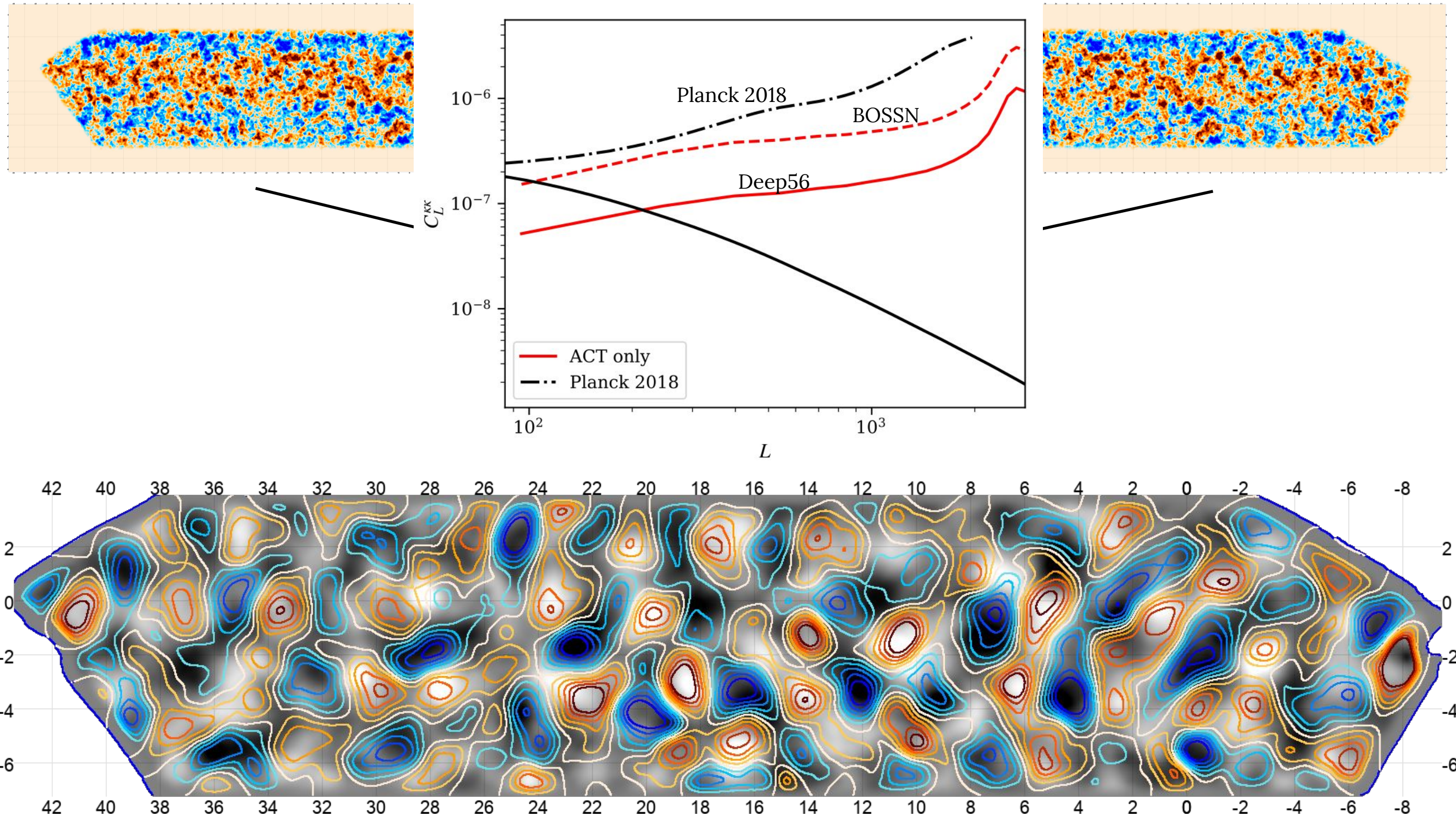
Deep56 ACTPol Lensing

CMB Lensing from ACT



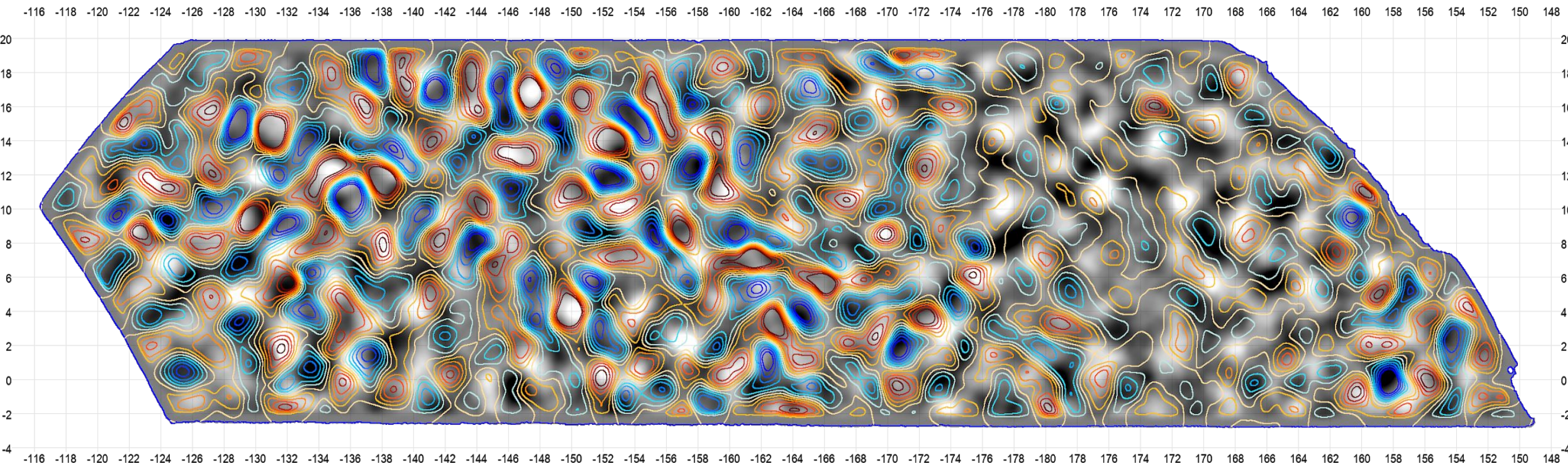
Deep56 ACTPol Lensing

CMB Lensing from ACT



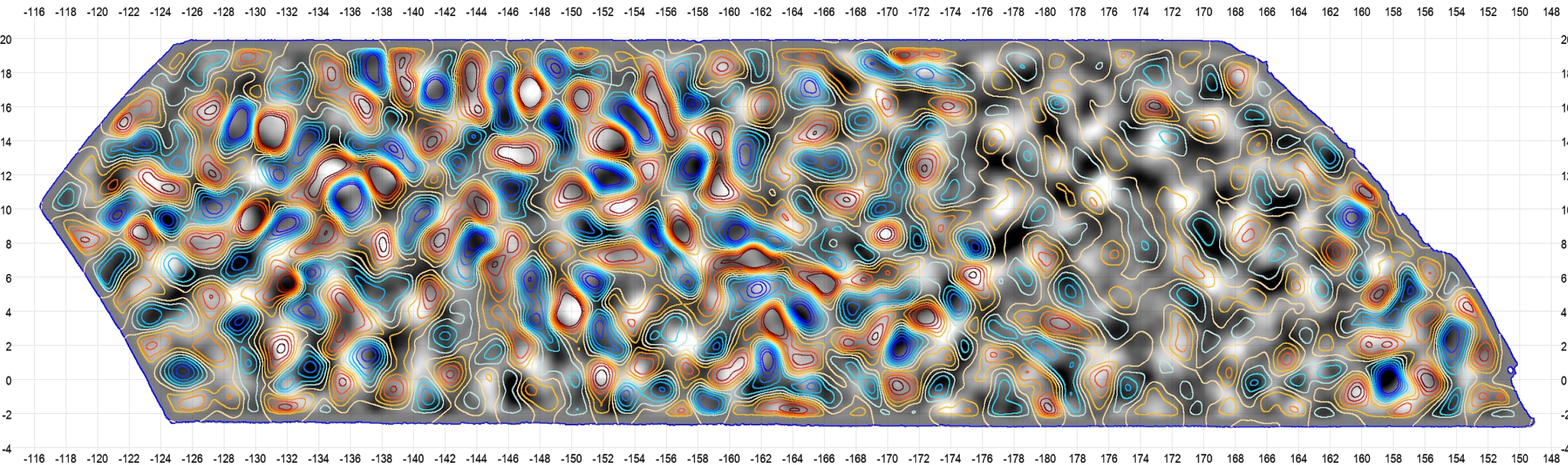
Deep56 ACTPol Lensing vs Planck CIB

CMB Lensing from ACT



BOSSN ACTPol Lensing vs Planck CIB

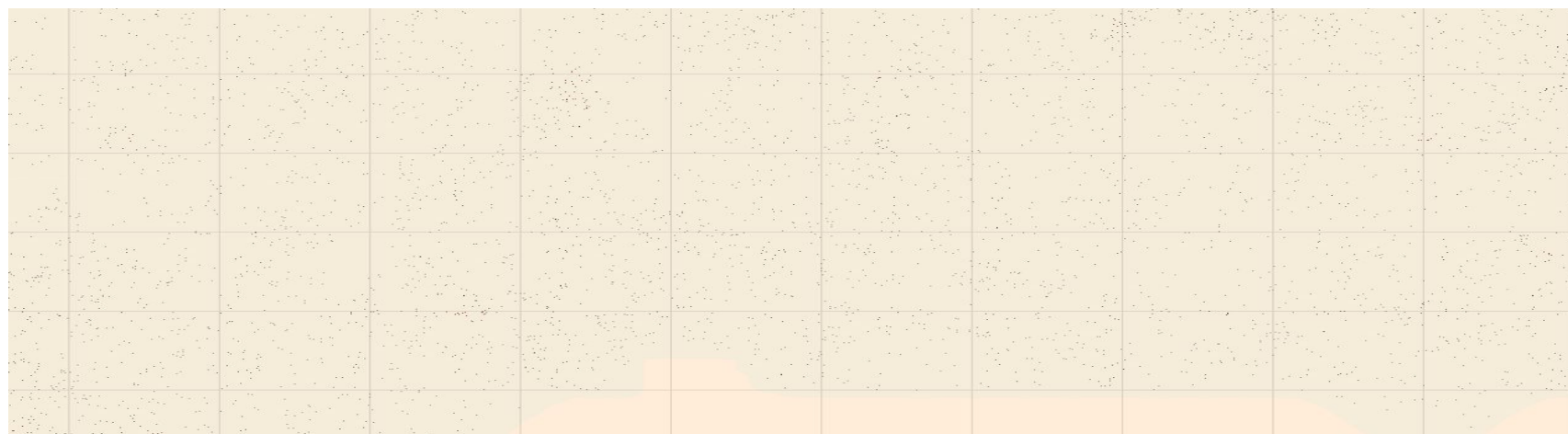
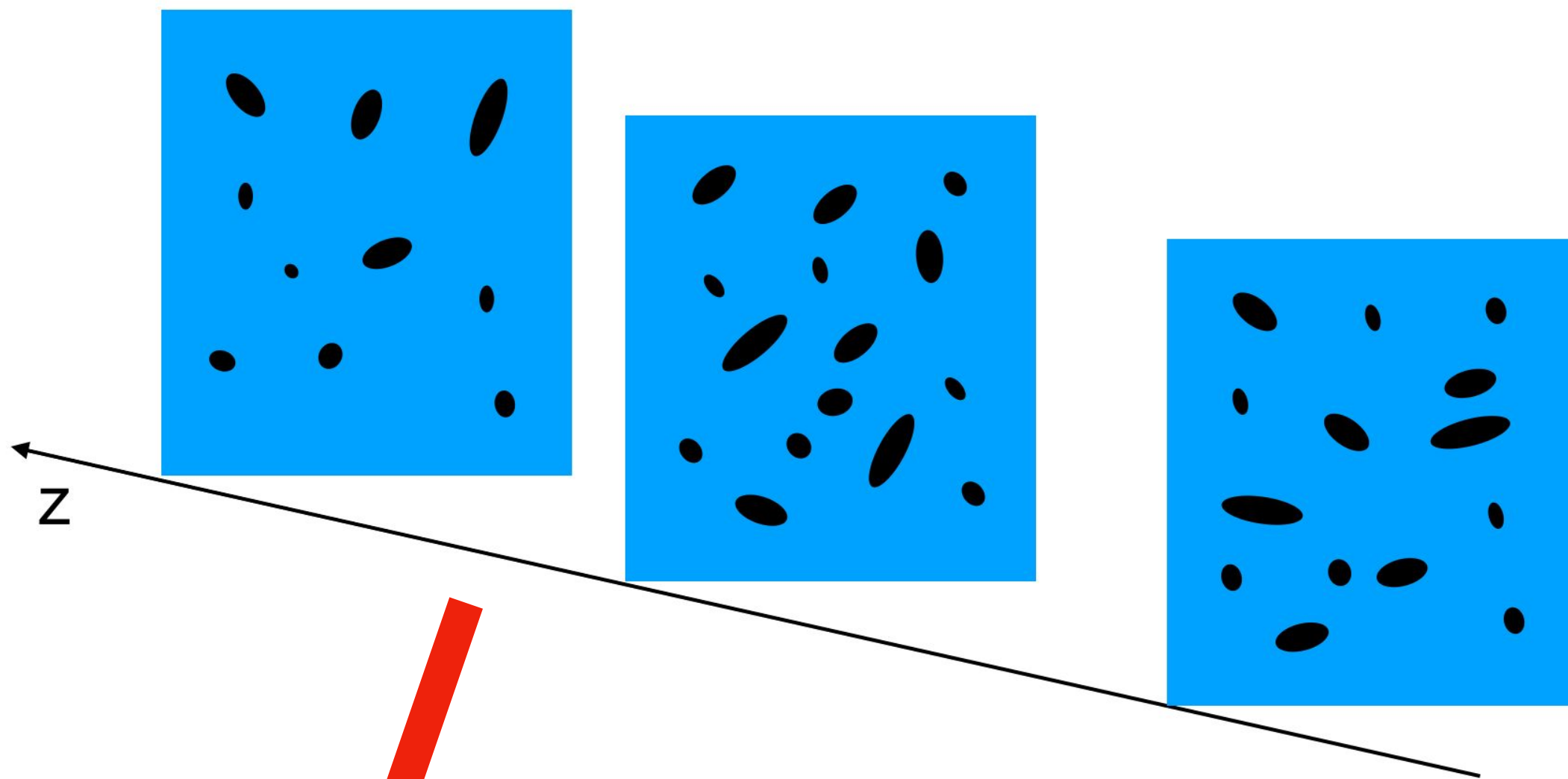
CMB Lensing from ACT



BOSSN ACTPol Lensing vs Planck CIB

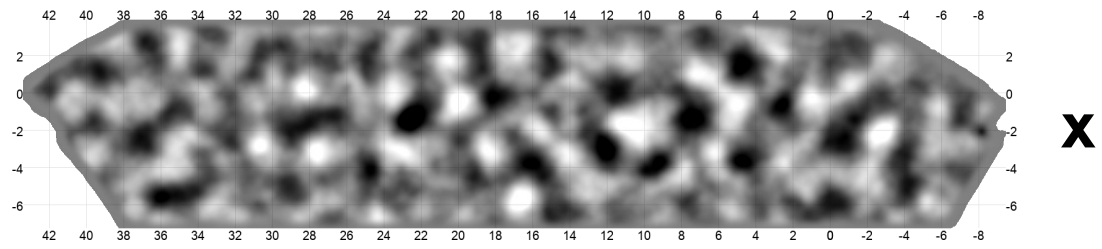
Can extract information on structure formation, e.g. its normalization amplitude.

Tomography with Galaxy Clustering

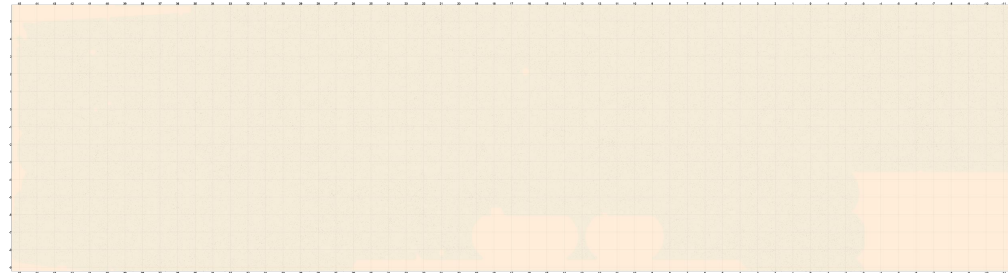


BOSS-CMASS

CMB Lensing x BOSS Galaxy Correlation

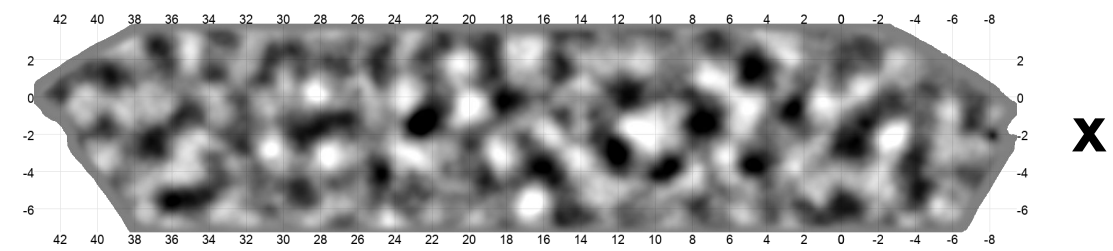


x

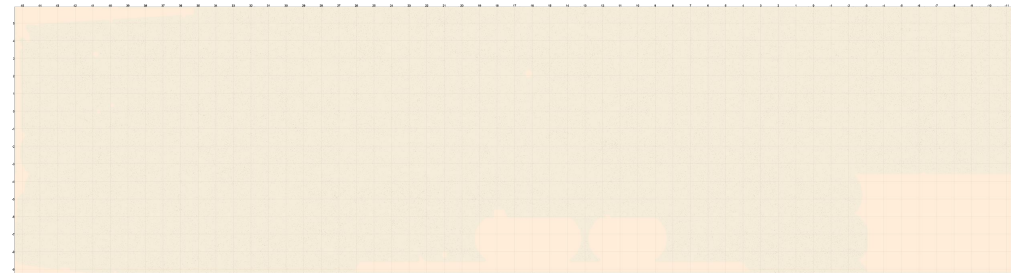


$$\propto b\sigma_8^2$$

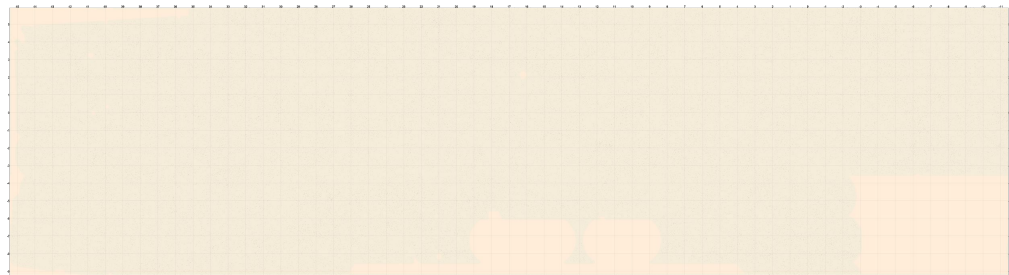
CMB Lensing x BOSS Galaxy Correlation



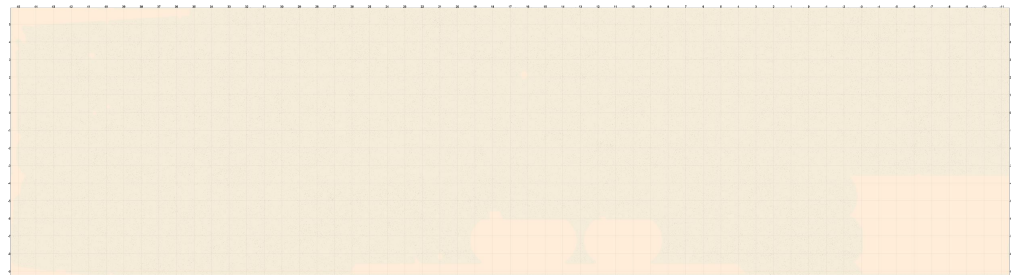
x



$$\propto b\sigma_8^2$$



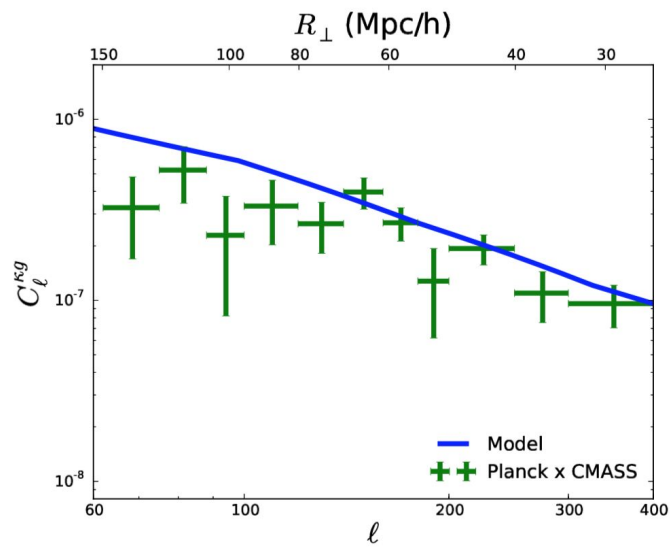
x



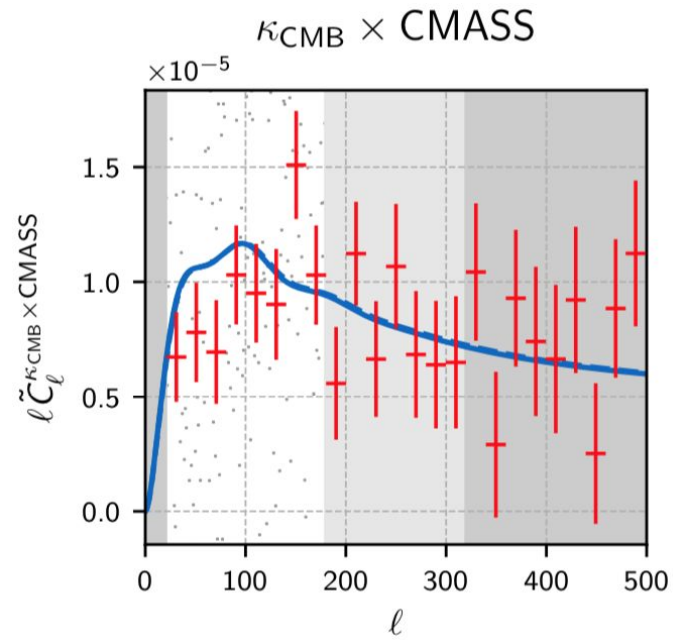
$$\propto b^2\sigma_8^2$$

Use ACT data and BOSS-CMASS to measure normalisation of the amplitude of structure redshift evolution!

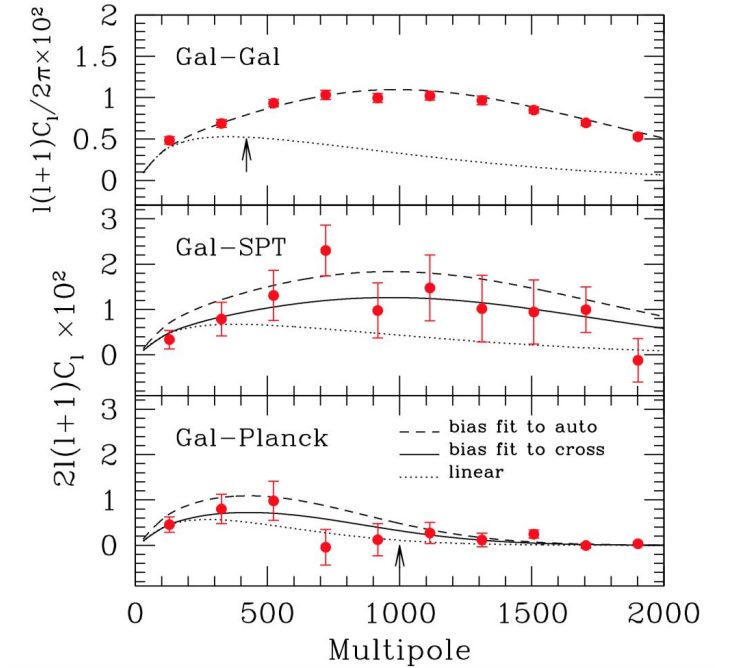
Many CMB LensingxGalaxy papers...



Pullen et al., 2016 (PlanckxBOSS)



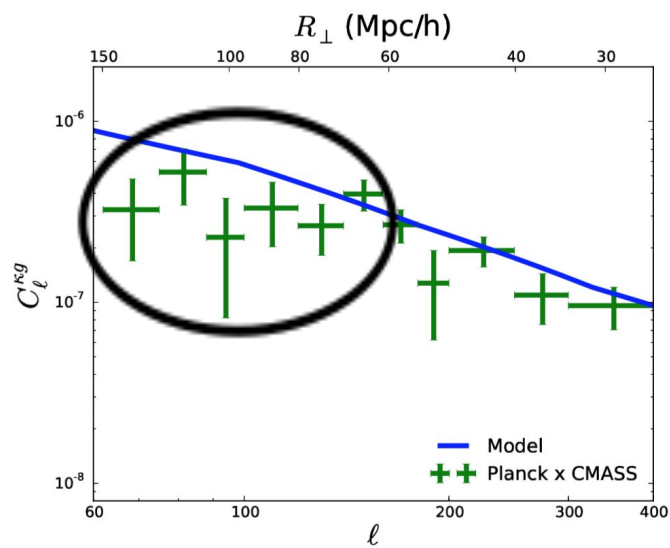
Doux et al., 2018 (PlanckxBOSS)



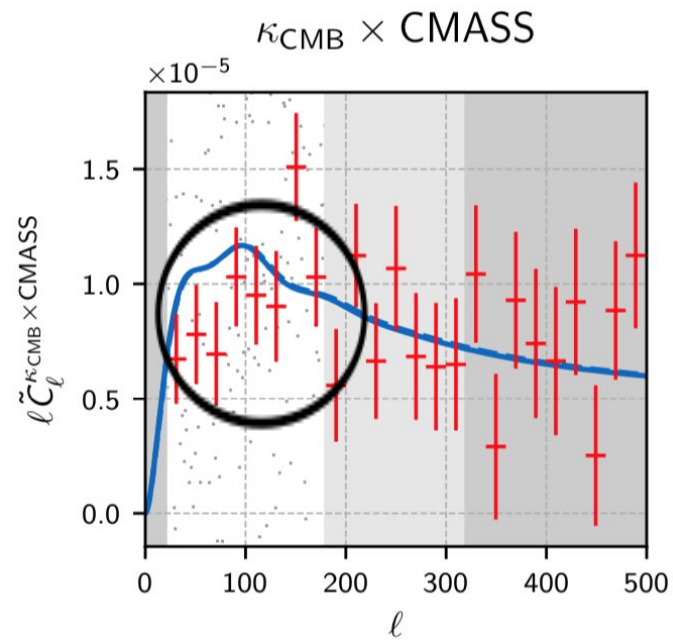
Giannantonio et al., 2016 (SPTxDES, PlanckxDES)

etc....

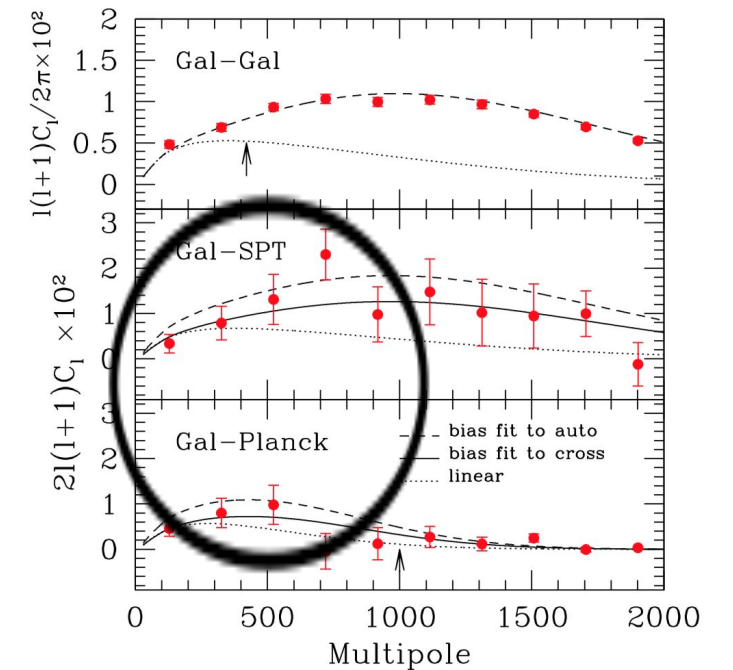
One frequent problem



Pullen et al., 2016 (PlanckxBOSS)



Doux et al., 2018 (PlanckxBOSS)

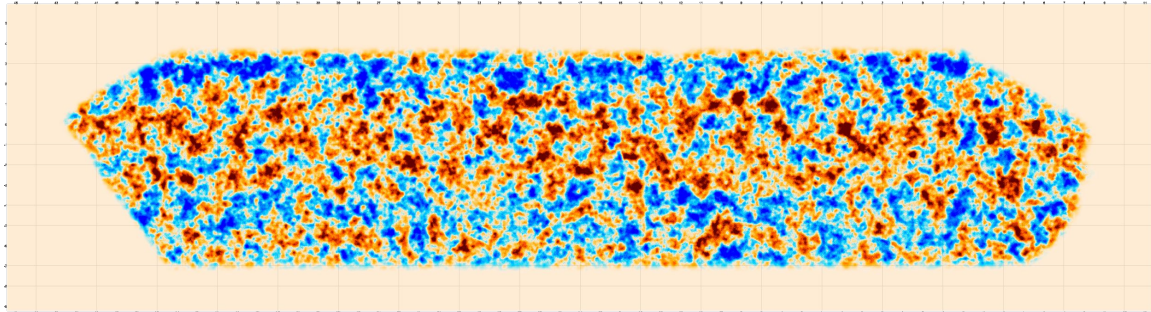


Giannantonio et al., 2016 (SPTxDES, PlanckxDES)

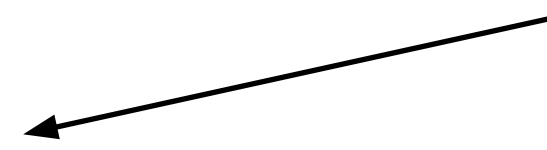
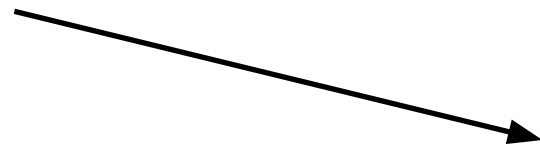
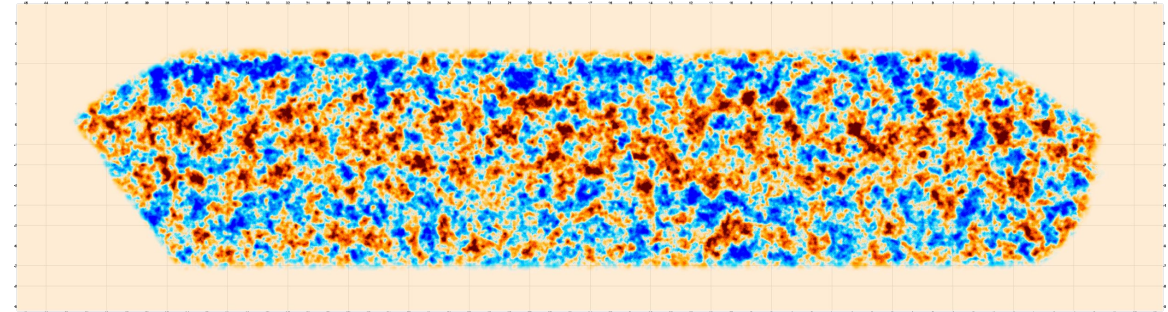
Fluctuation, systematic effects or new physics on large scales?

Systematics: tSZ contamination

CMB+tSZ+...

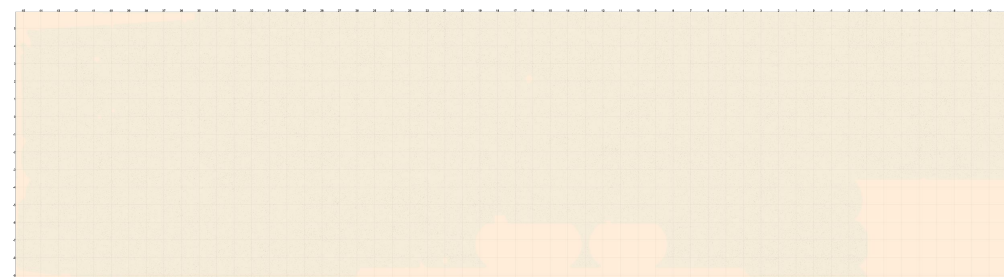


CMB+tSZ+...



Quadratic
Estimator

X



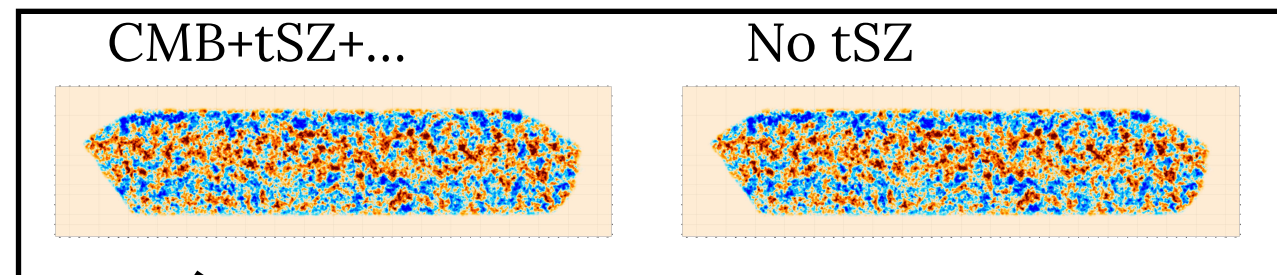
Important for TT dominated
lensing maps

Not too much important
for Planck

$$\sim \langle T_{CMB} T_{CMB} g \rangle + \langle yyg \rangle$$

Negative Bias ~ 10-20%
Van Engelen (2014)
Baxter (2018)

Removing tSZ contamination in CMB Lensing x Galaxy



Madhavacheril, Hill,
2018 PRD

Hu, DeDeo, Vale
(2007)

Non Gradient Leg

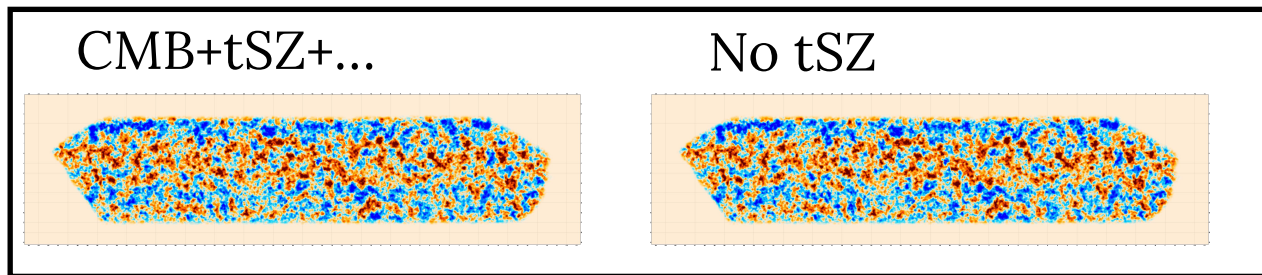
Gradient Leg

$$\kappa \sim \nabla \cdot (T \nabla T_{nosz})$$

Removing tSZ contamination in CMB Lensing x Galaxy

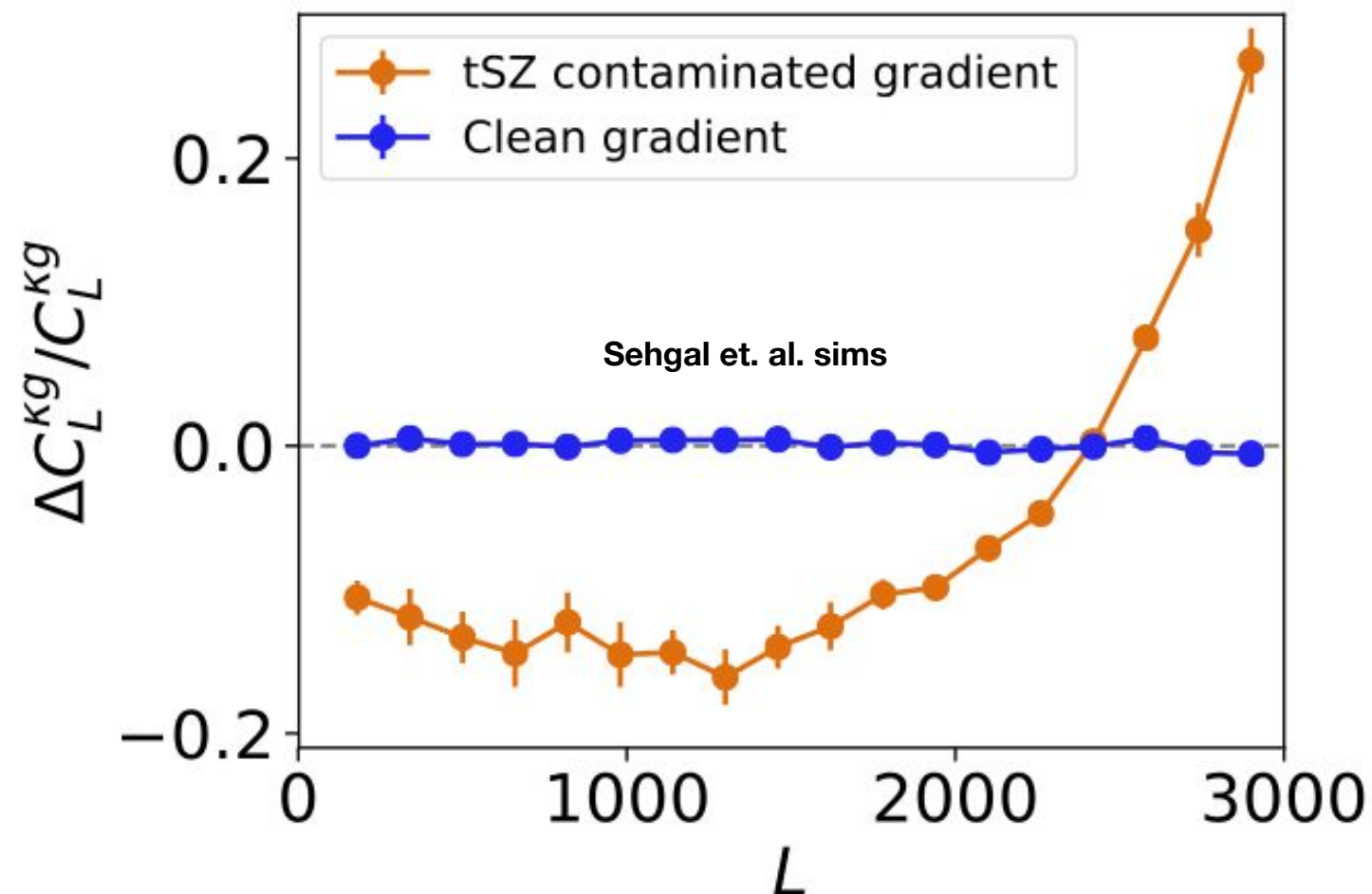
Non Gradient Leg

Gradient Leg



Madhavacheril, Hill,
2018 PRD

Hu, DeDeo, Vale
(2007)



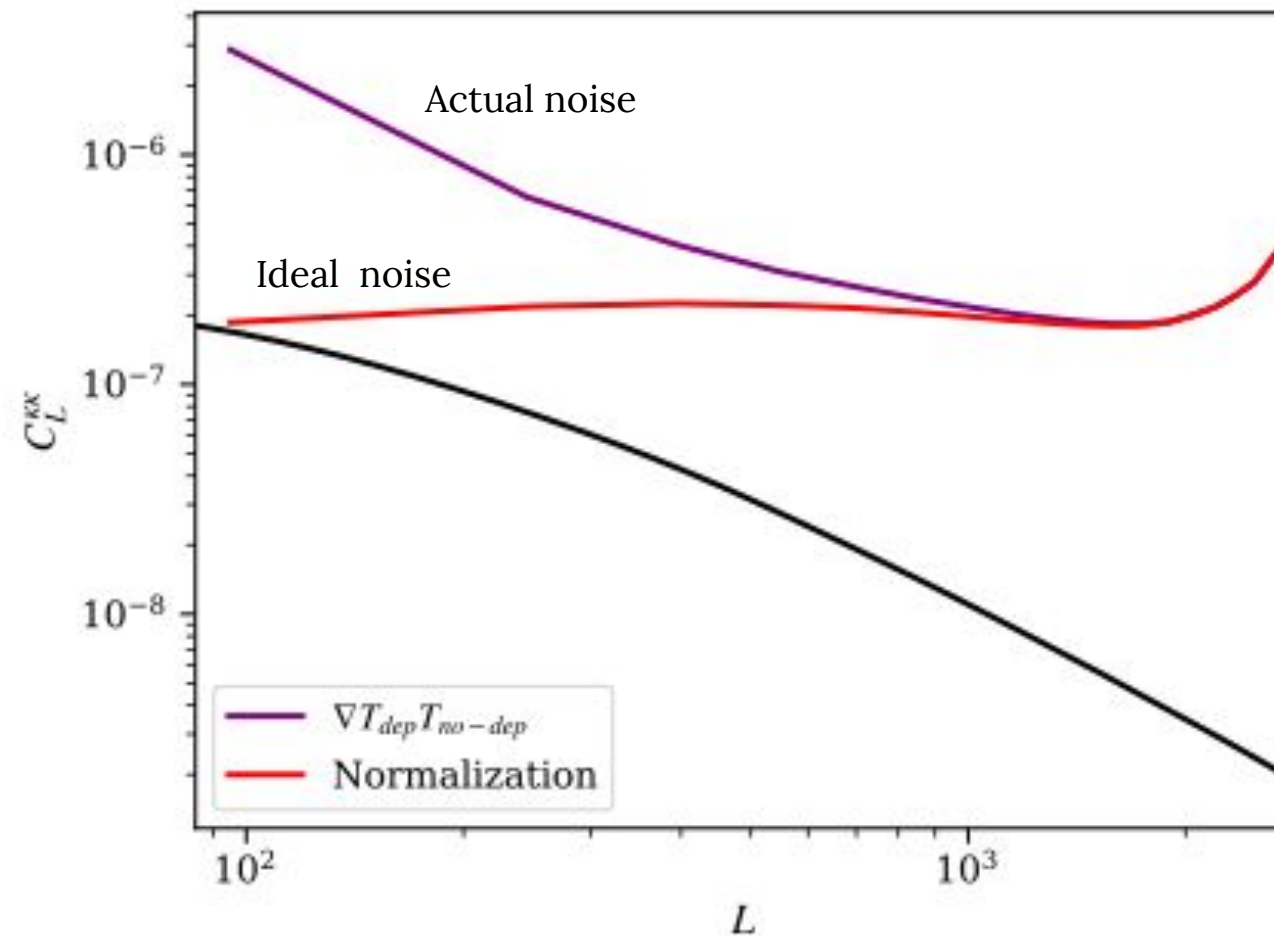
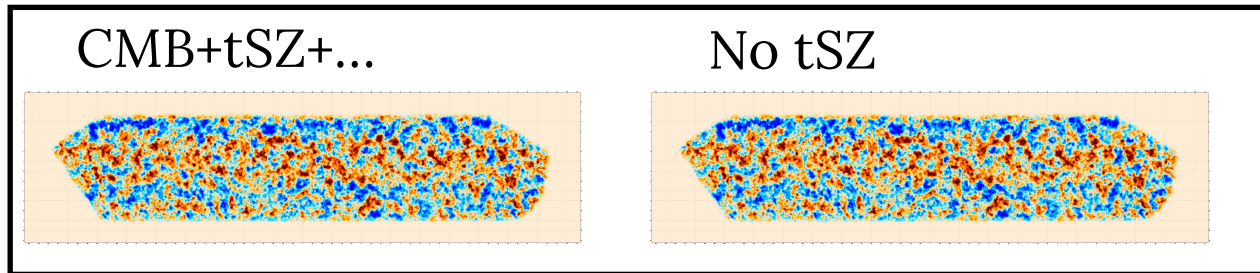
Bias $\ll 1\%$!

Madhavacheril, Hill, 2018 PRD

Removing tSZ contamination in CMB Lensing x Galaxy

Non Gradient Leg

Gradient Leg



Removing tSZ contamination from lensing

Non Gradient Leg

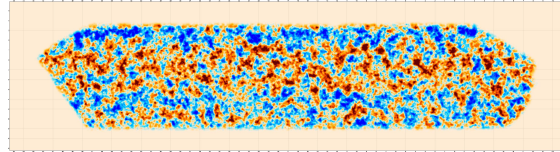
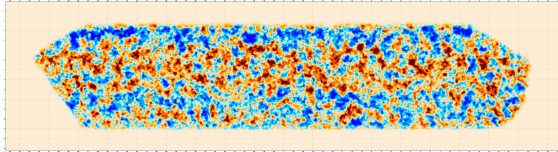
Gradient Leg

Non Gradient Leg

Gradient Leg

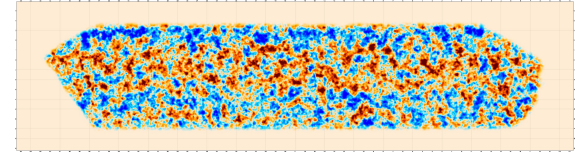
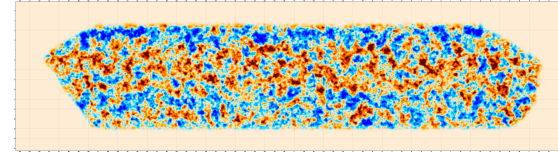
CMB+tSZ+...

No tSZ

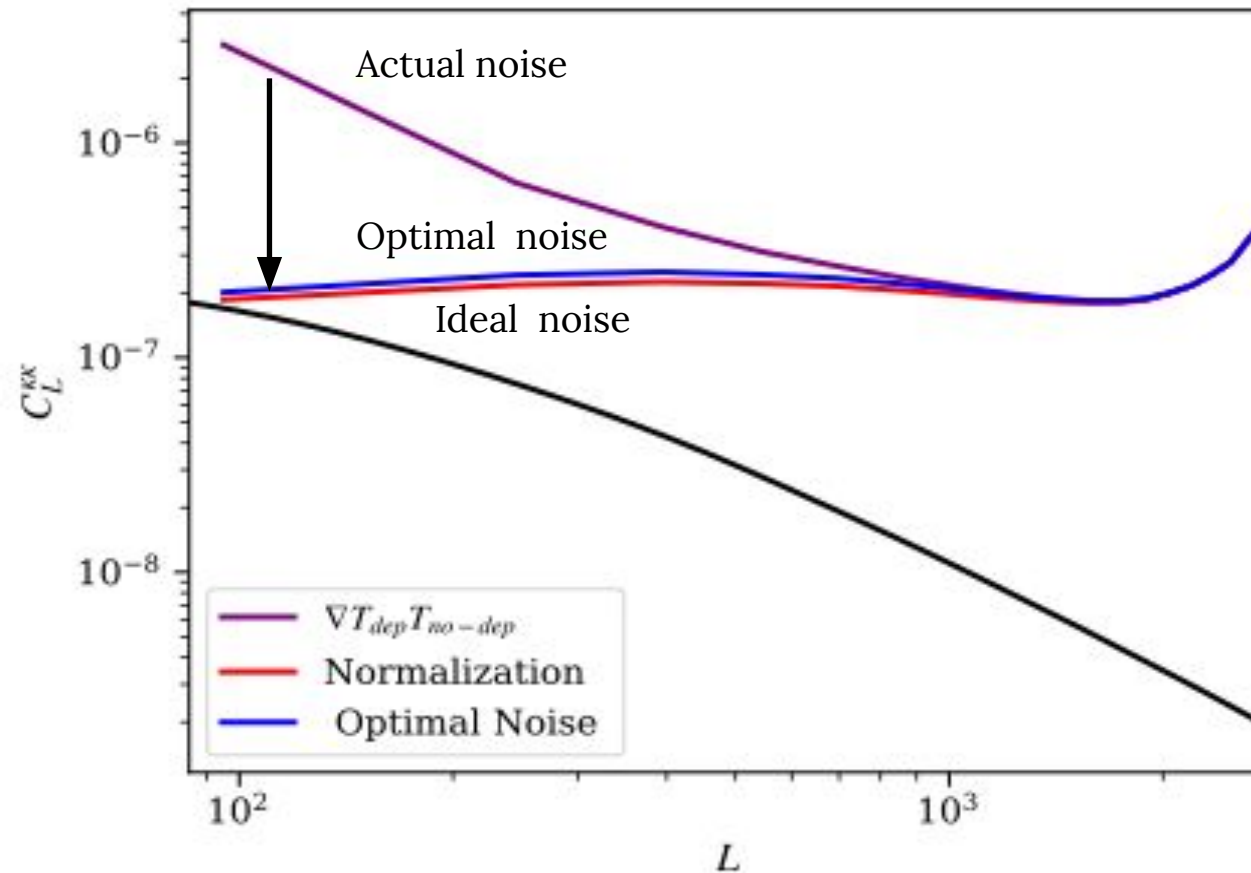


No tSZ

CMB+tSZ+...

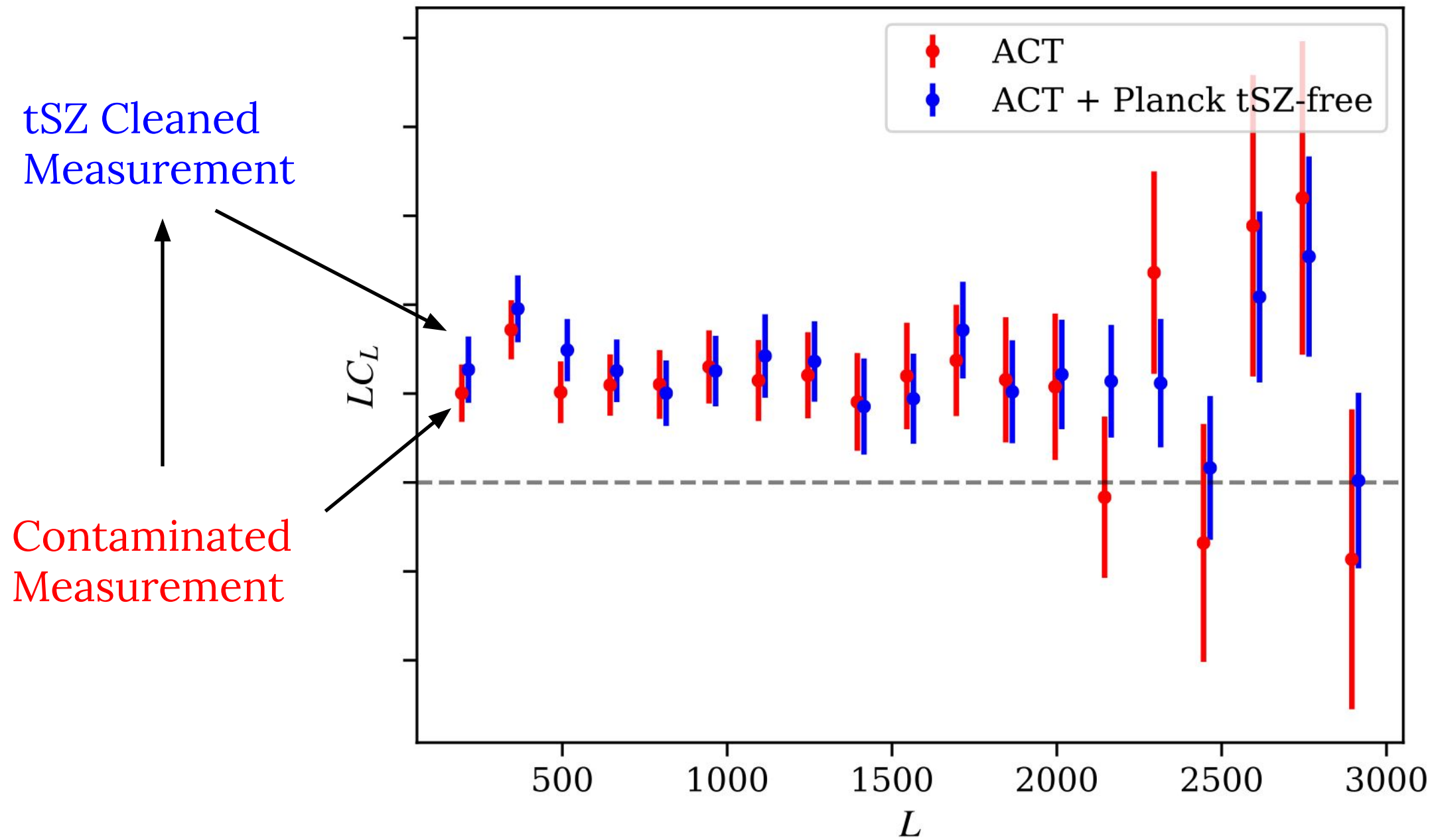


New Mixed Quadratic Estimator

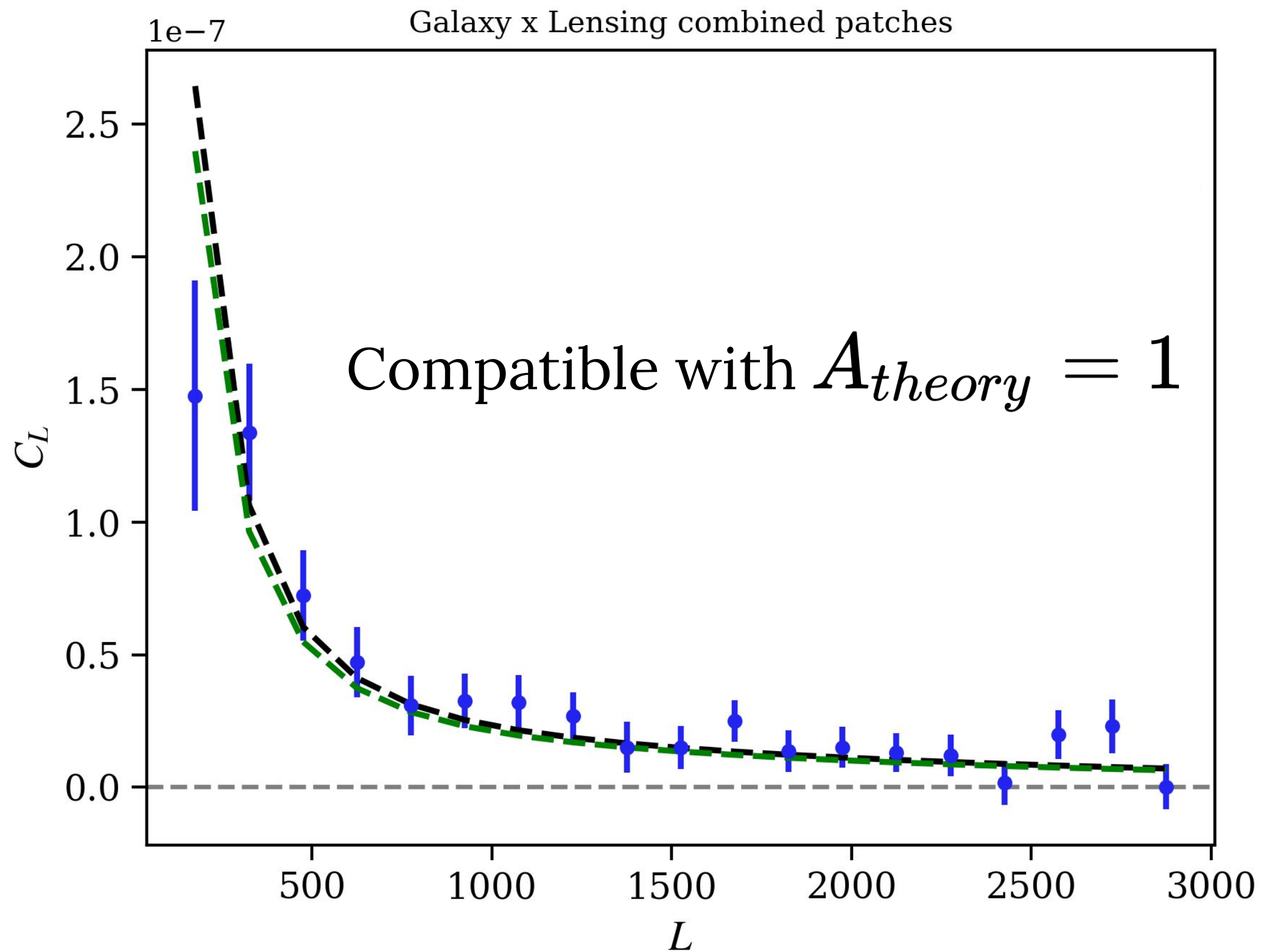


Ideal noise recovered!

Contaminated vs Non Contaminated measurement

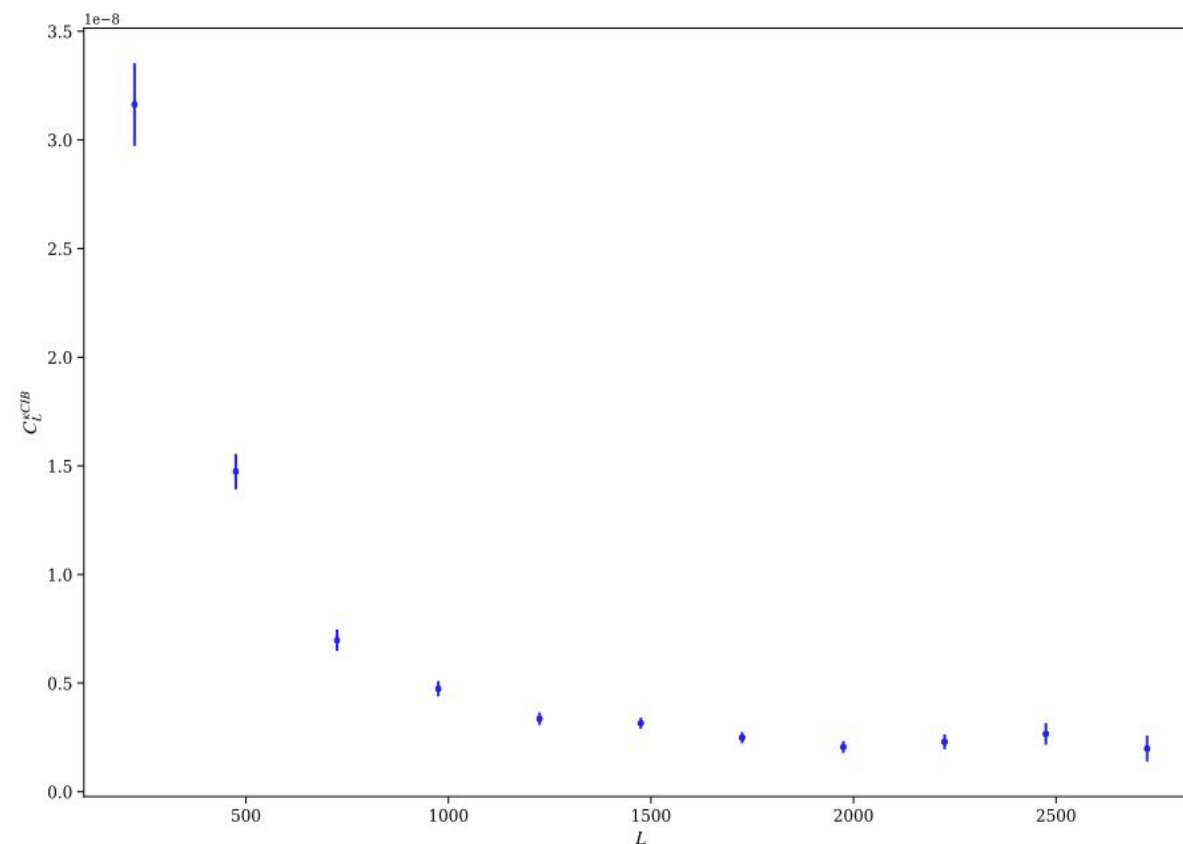


Cosmological Analysis



Next Steps

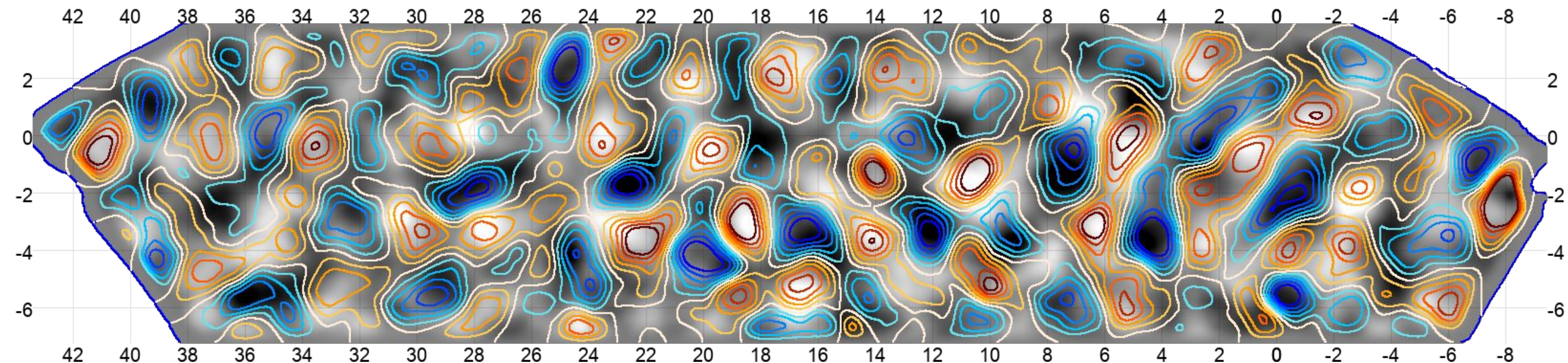
- Apply our pipeline to obtain cleaned high S-N cross-correlations, like DES and Wise.
 - Other interesting cross correlation, e.g. CIB



- Temperature still important for AdvACT, Simons Observatory lensing. There are already several cleaning methods, e.g. bias hardening, shear estimator and now also mixed estimator. We want to do better.
 - Working to derive optimal foreground mitigation strategy.

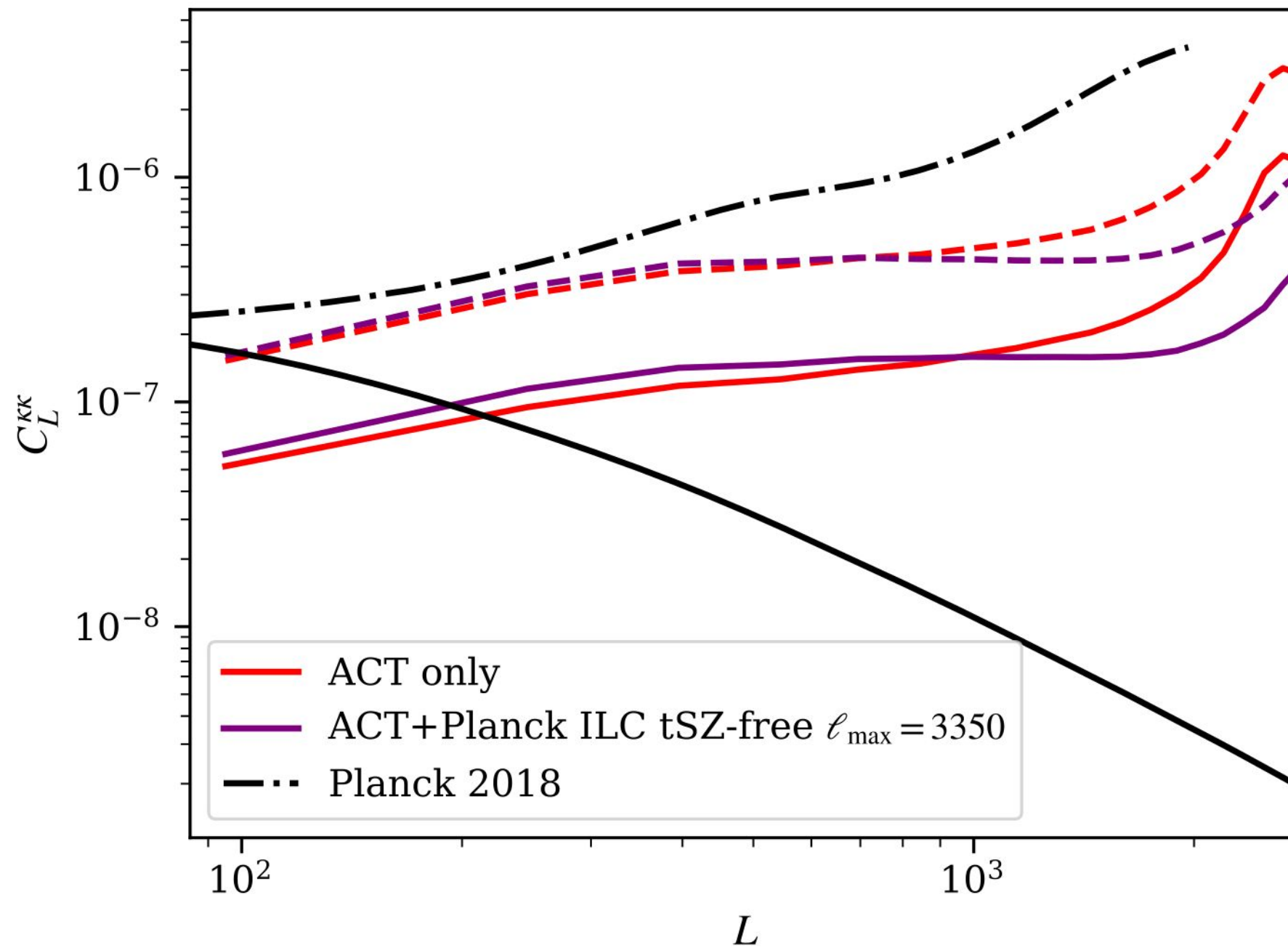
Conclusions

- Constructed new, low noise, signal dominated ACT Lensing maps, over more than 2000 sq. deg. of sky, overlapping with several surveys. Available soon!
- Major problem: SZ foregrounds. Our solution: new multifrequency lensing cleaning method nulls bias with minimal S-N penalty
- This gave us a robust BOSS-CMASSxACT CMB Lensing cross correlation.

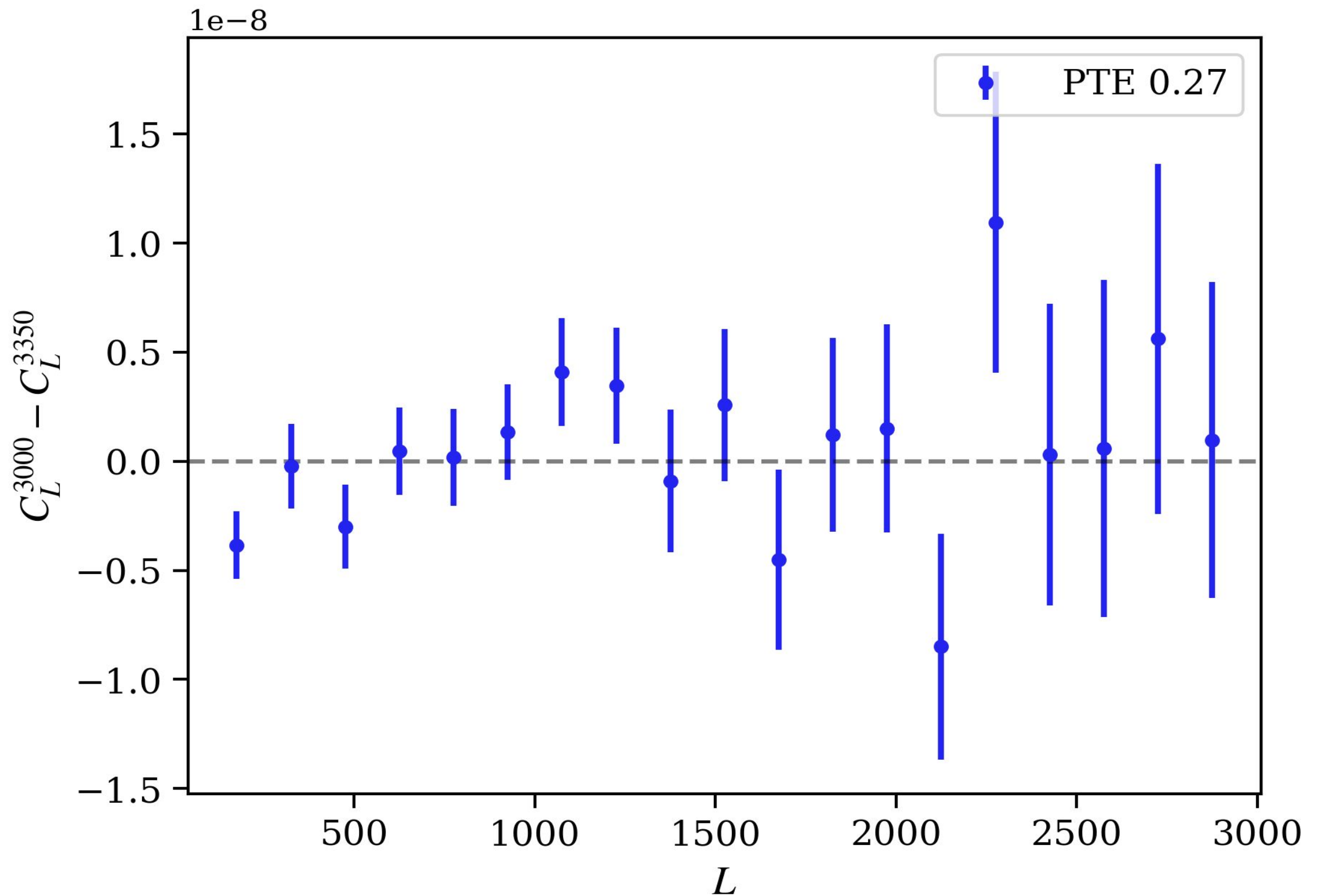


Backup slides

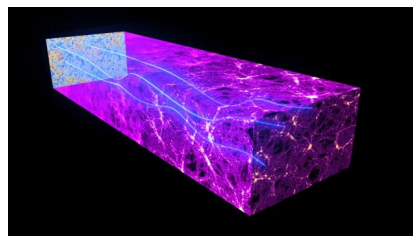
Noise Curves



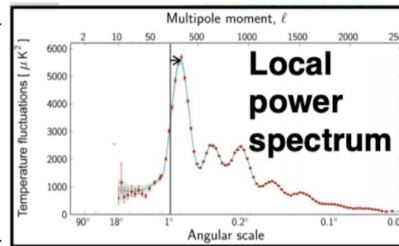
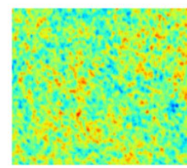
Foreground test



Systematics: tSZ contamination in kxg

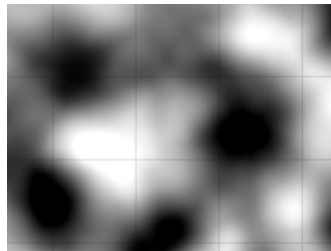
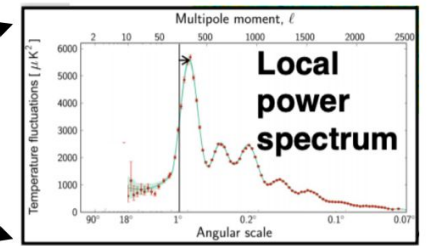
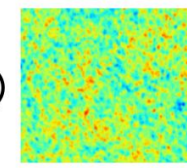
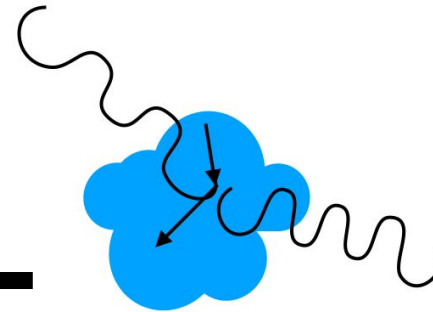


From ESA,
Planck

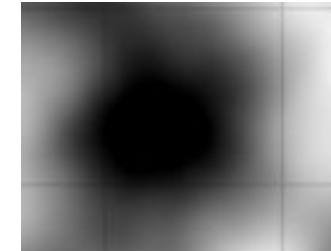


From
Schmitfull

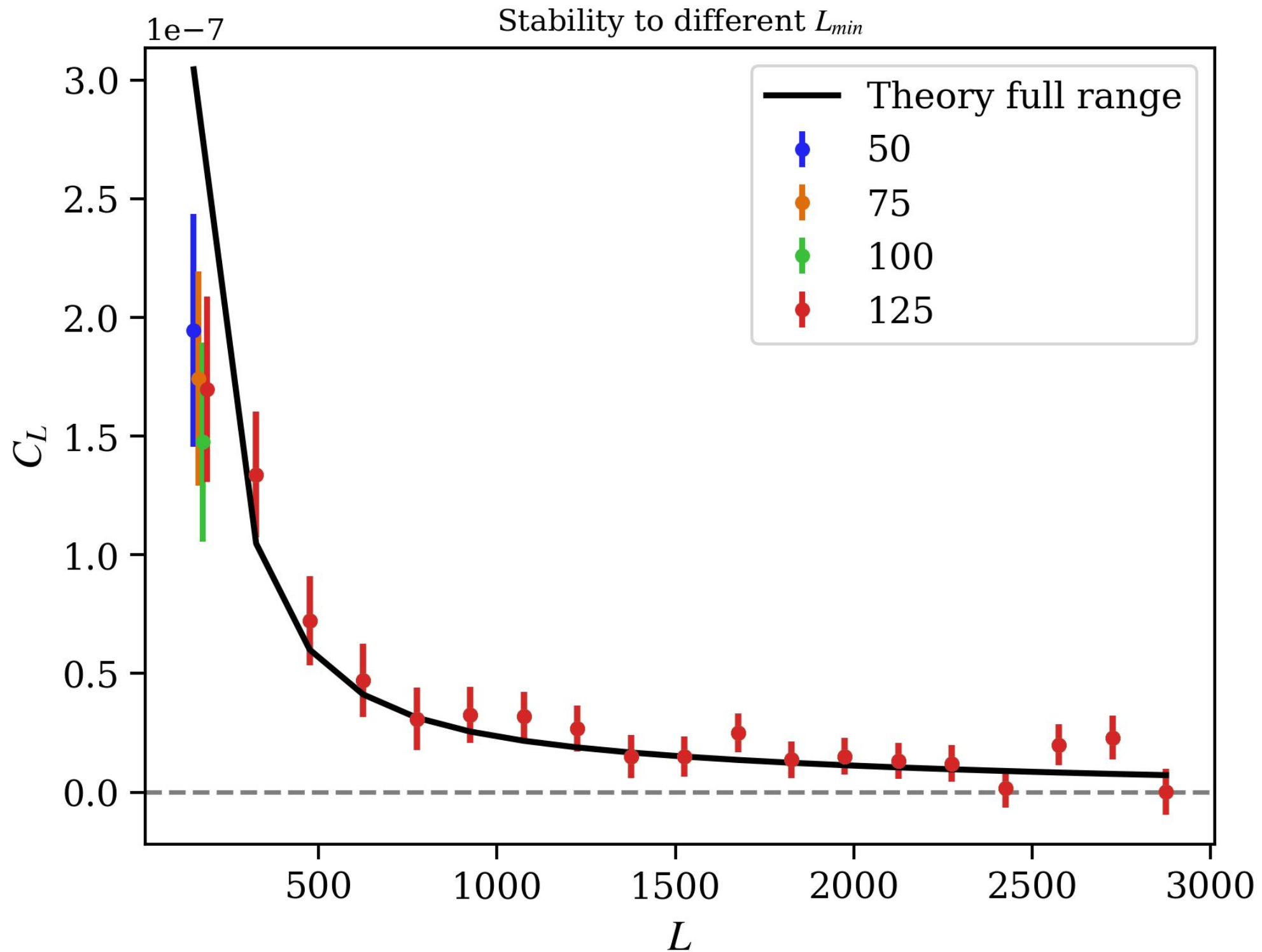
+



+



L min Stability



Mixed Estimator

