Update: Bias from Foregrounds

Joel Meyers, Cynthia Trendafilova, Srinivasan Raghunathan & Benjamin Wallisch

Can We Infer Unbiased Estimates?

- Inferred values of cosmological parameters will be most precise at the time.
- But also accurate?

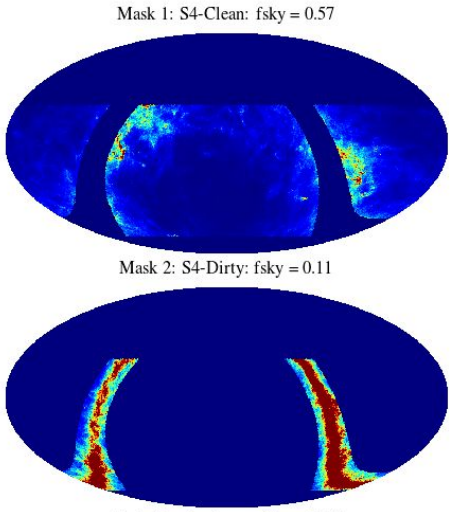
- Example:
  - We aim and optimize for $\sigma(N_{\rm eff}) \sim 0.03$.
  - But is the inference of the mean value of $N_{\rm eff}$ reliable with the same specifications, including $\ell_{\rm max}$ and $f_{\rm sky}$?
    (Difference between standard neutrinos and potentially claiming new light relics!)

- We want to maximize the employed sky fraction and maximum multipoles.

→ Might galactic foregrounds be an issue?

Note: All figures by Srini.

Galactic Foregrounds

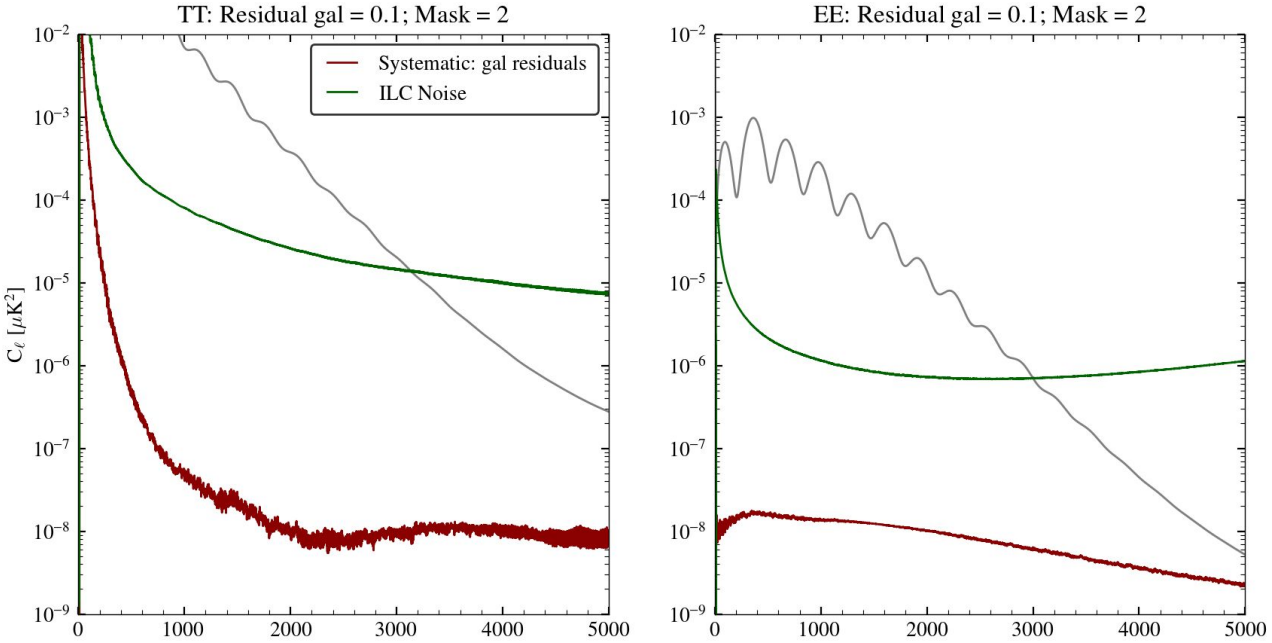


S4 masks overlayed on galactic dust emission at 145 GHz.

- Even “S4-Clean” will include components obscuring the primary CMB.
- pySM3 simulations → ILC curves on “S4-Clean”.
- Fisher code → forecasted uncertainties.
- However: Might uncertainties in the modeling of galactic emission bias cosmological estimates?
- [So far: focus on galactic foregrounds.]

Galactic Foreground Mismodeling?

- Assume galactic emission is mismodeled by 1% or 10%,
  i.e. amplitude of galactic dust component in the TT and EE power spectra is systematically off by 1%/10% (not yet for TE, cf. pySM3).



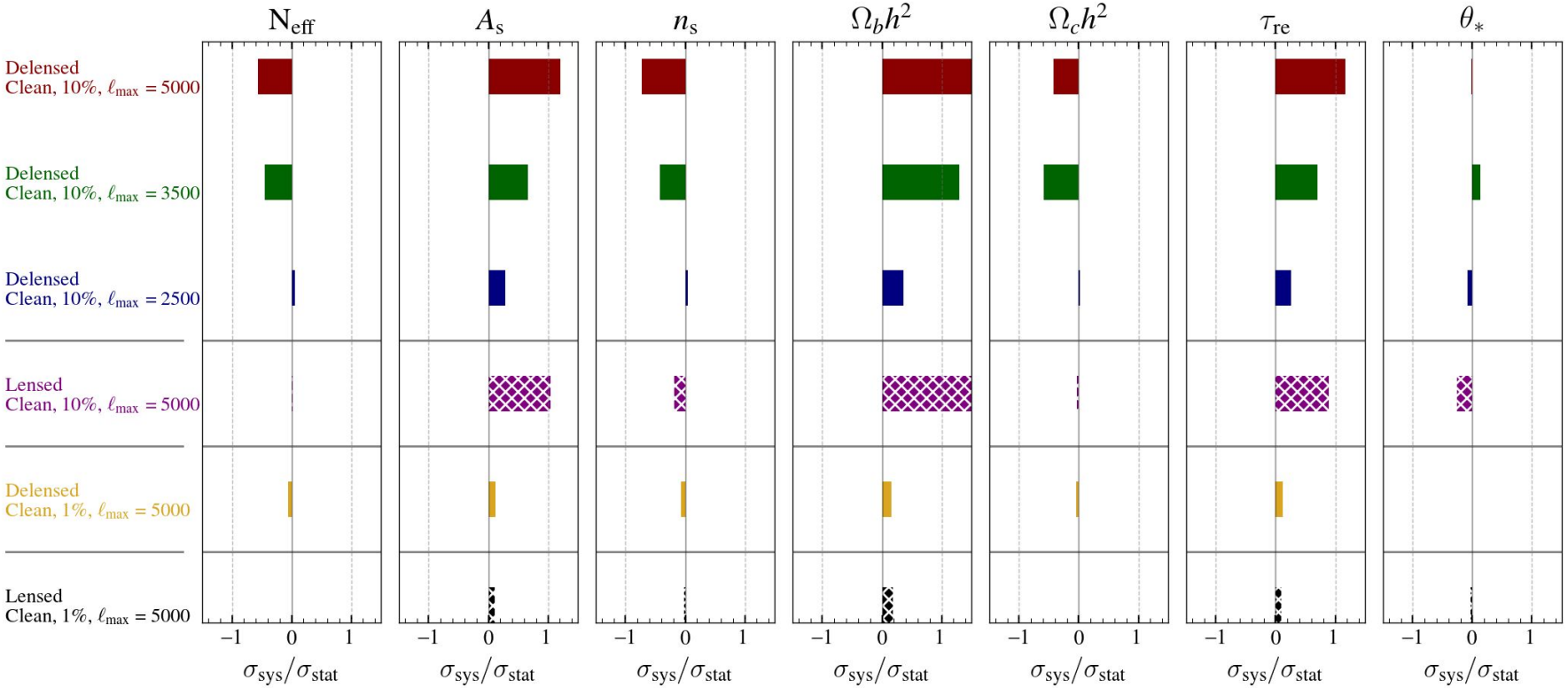
Fisher Forecast with Bias

- Fisher-based estimation of the bias due to systematic uncertainties.
- Following Huterer & Takada (astro-ph/0412142); Loverde, Hui & Gaztanaga (astro-ph/0611539); Amara & Réfrégier (0710.5171).
- Observed spectrum: $C_\ell^{\rm obs} = C_\ell + C_\ell^{\rm sys} + N_\ell$
- Fisher matrix: $F_{\alpha\beta} = \sum_\ell \frac{\partial C_\ell^X}{\partial\theta_\alpha}[{\rm Cov}_\ell^{XY}]^{-1}\frac{\partial C_\ell^Y}{\partial\theta_\beta}$
- Bias: $b[\hat\theta_\alpha] = \langle\hat\theta_\alpha\rangle - \langle\theta_\alpha^{\rm true}\rangle = [F^{-1}]_{\alpha\beta}B_\beta$

(for small residual systematics)

$$B_\beta = \sum_\ell [C_\ell^X]^{\rm sys}[{\rm Cov}_\ell^{XY}]^{-1}\frac{\partial C_\ell^Y}{\partial\theta_\beta}$$

Forecasted Biases [Preliminary]



Take-Aways

- Bias is larger for delensed spectra than for lensed spectra.
- Bias increases when residual galactic emission increases.
- Bias increases when ℓ_{max} increases.

- However: We need delensed spectra and large ℓ_{max} to get to the target.

→ Need to get the bias under control.

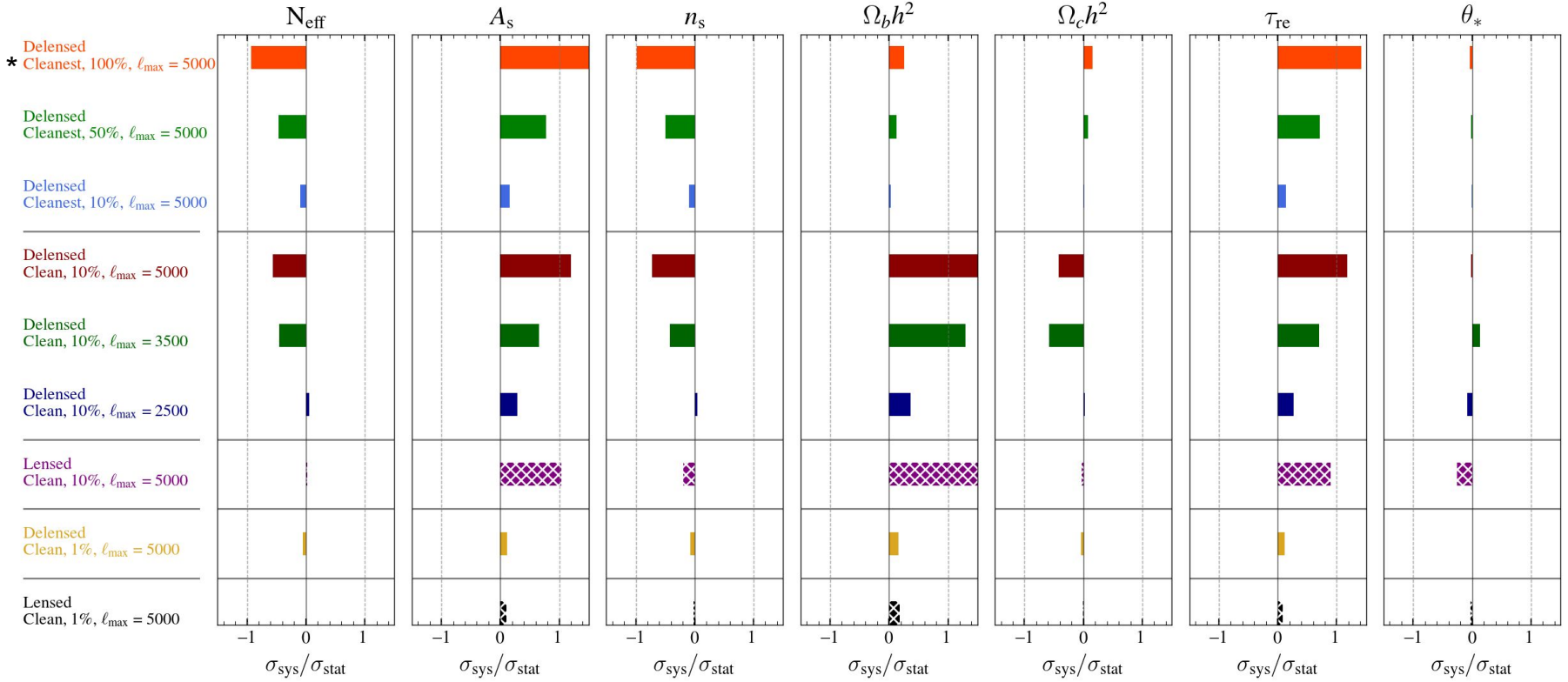
[Additionally: differences between CAMB/CLASS/nonlinear clustering modeling; see Colin Hill's talk for overview of detailed study.]

Current Plans

- We are in contact with Brandon Hensley and Susan Clark.
- Use TE noise curves from updated pySM simulations and include potential residuals.
- Vary not only galactic dust amplitude, but also the tilt of its power spectrum; marginalize over these parameters with suitable (informed?) priors.
- Split “S4-Clean” patch into more sub-patches (e.g. HI column density).
- Explore more sophisticated component separation and other techniques.
- Your ideas/suggestions?

Backup Slides

Forecasted Biases [Preliminary]



*rescaled to $f_{\rm sky} = 0.57$