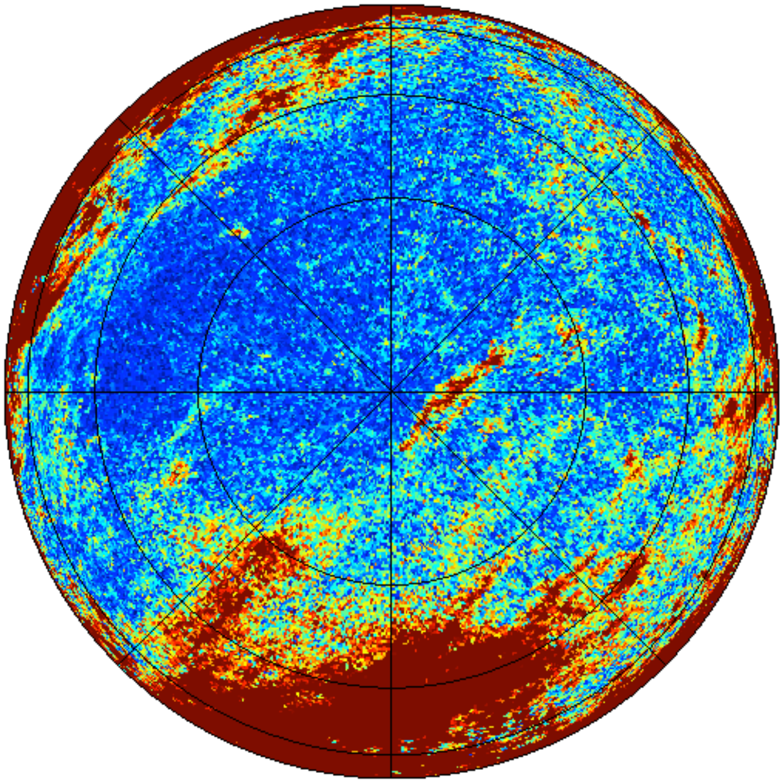
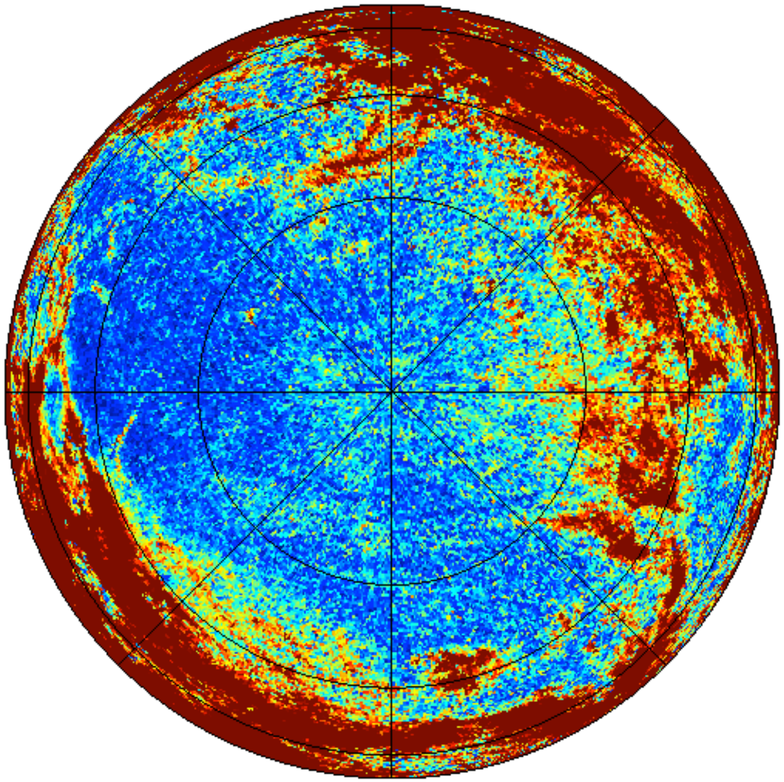
BICEP/Keck Data Constrains Dust Models at High Latitude (and 150 GHz)

Clem Pryke - San Diego Foregrounds Workshop
Nov 29 2017

Planck 353GHz polarized intensity (ortho view)

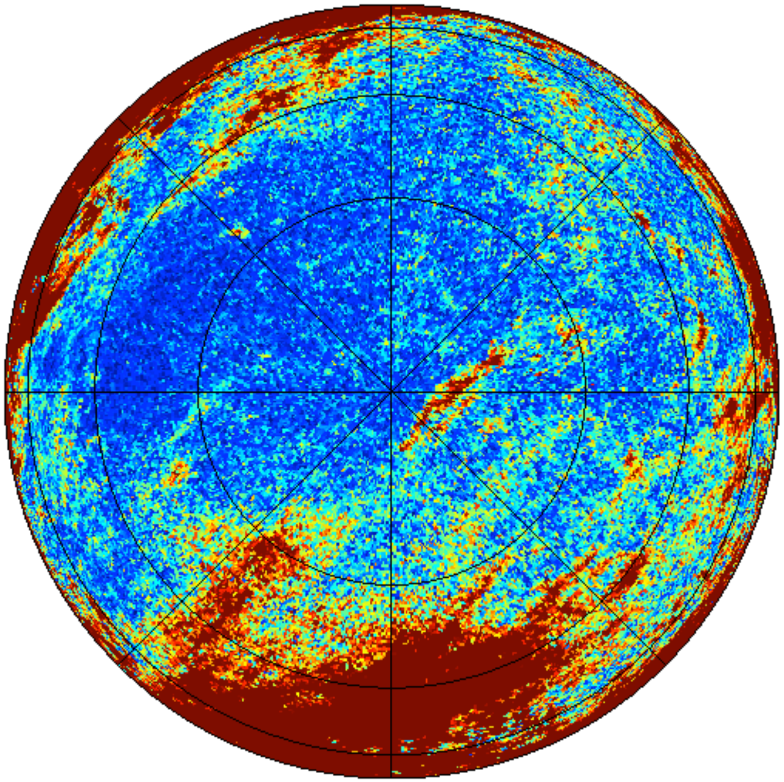


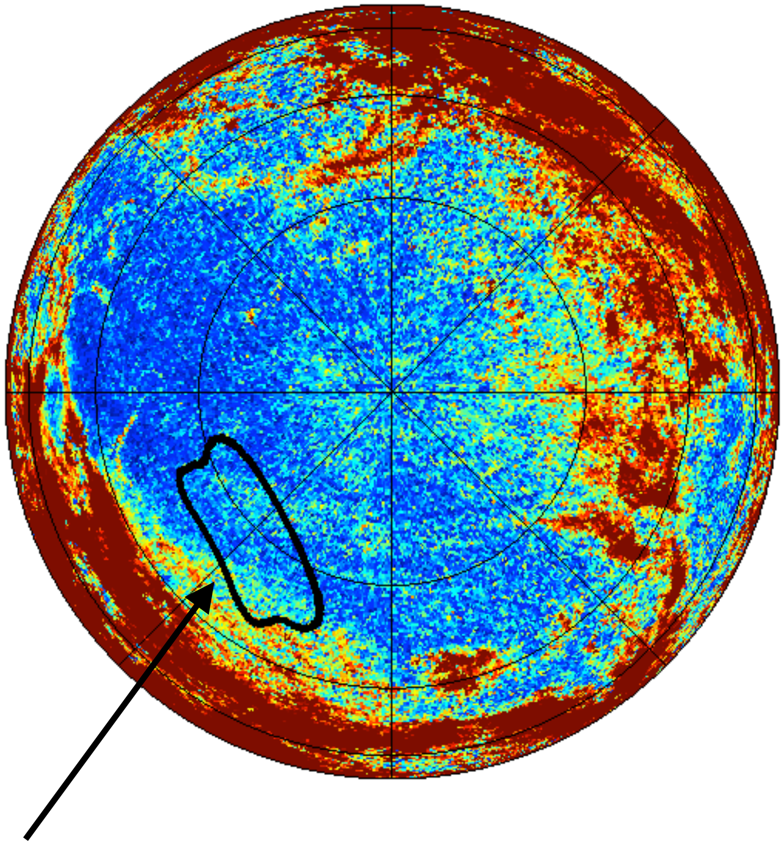


Color stretch 0 to 100uK

Take standard Planck 353GHz Q/U maps, downgrade to 0.5deg pixels (nside=128), take $P=\mathrm{sqrt}(Q^2+U^2)$, plot orthographic projection

Planck 353GHz polarized intensity (ortho view)

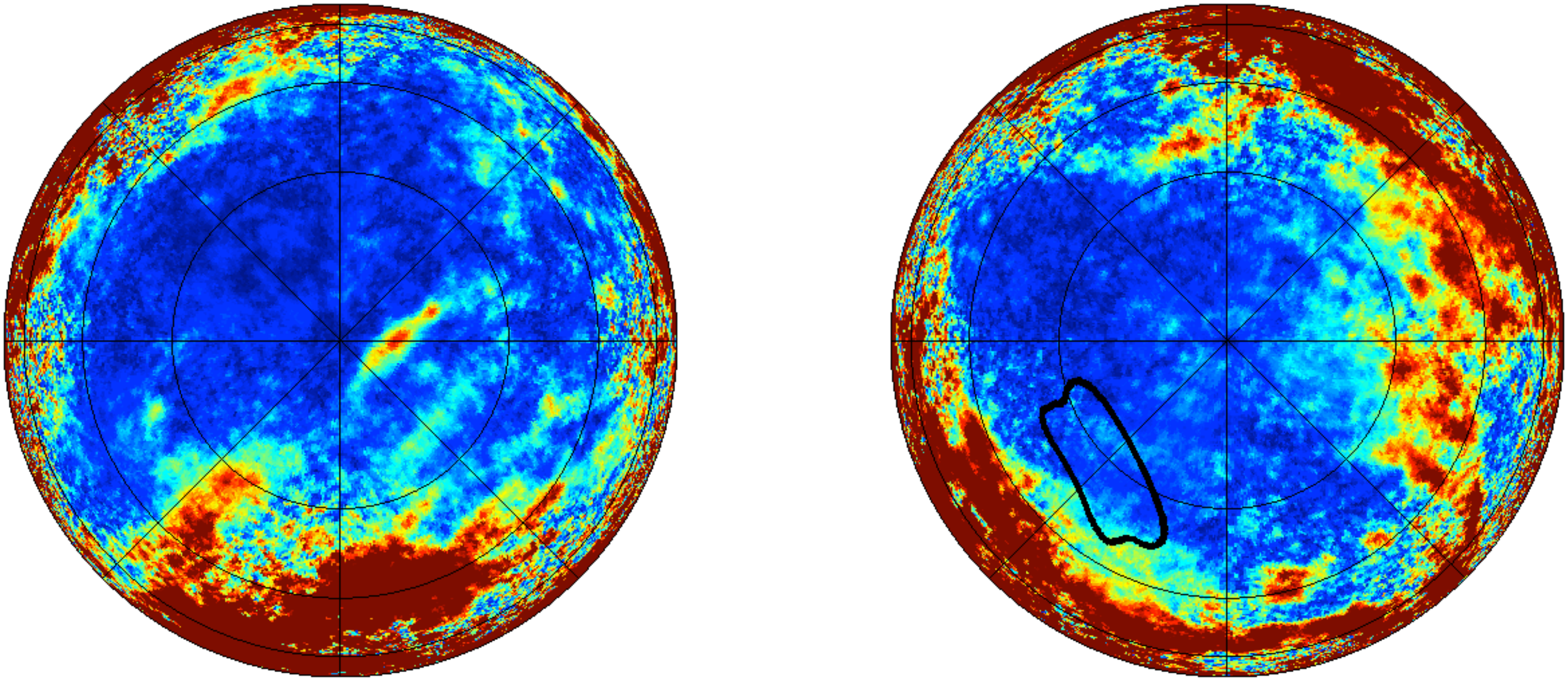




Color stretch 0 to 100uK

There is one place on the high latitude sky where we have a higher signal-to-noise measurement of the dust pattern

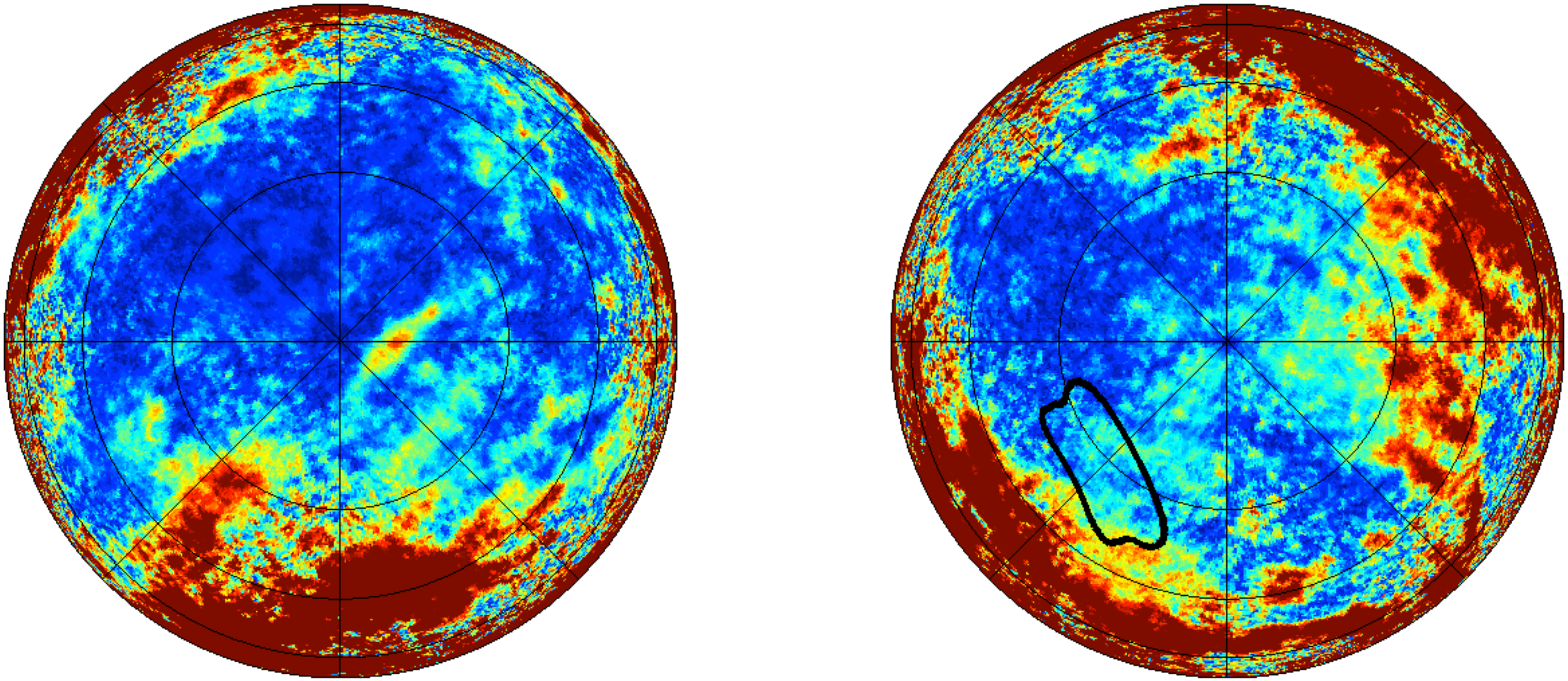
PySM dust model 1 at 155GHz polarized intensity



Color stretch 0 to 5uK

PySM offers several dust models. The noise dominated fine scale structure of the Planck 353GHz map is filtered out and filled back in with a Gaussian realization, and the pattern is then extrapolated to other frequencies according to some recipe.

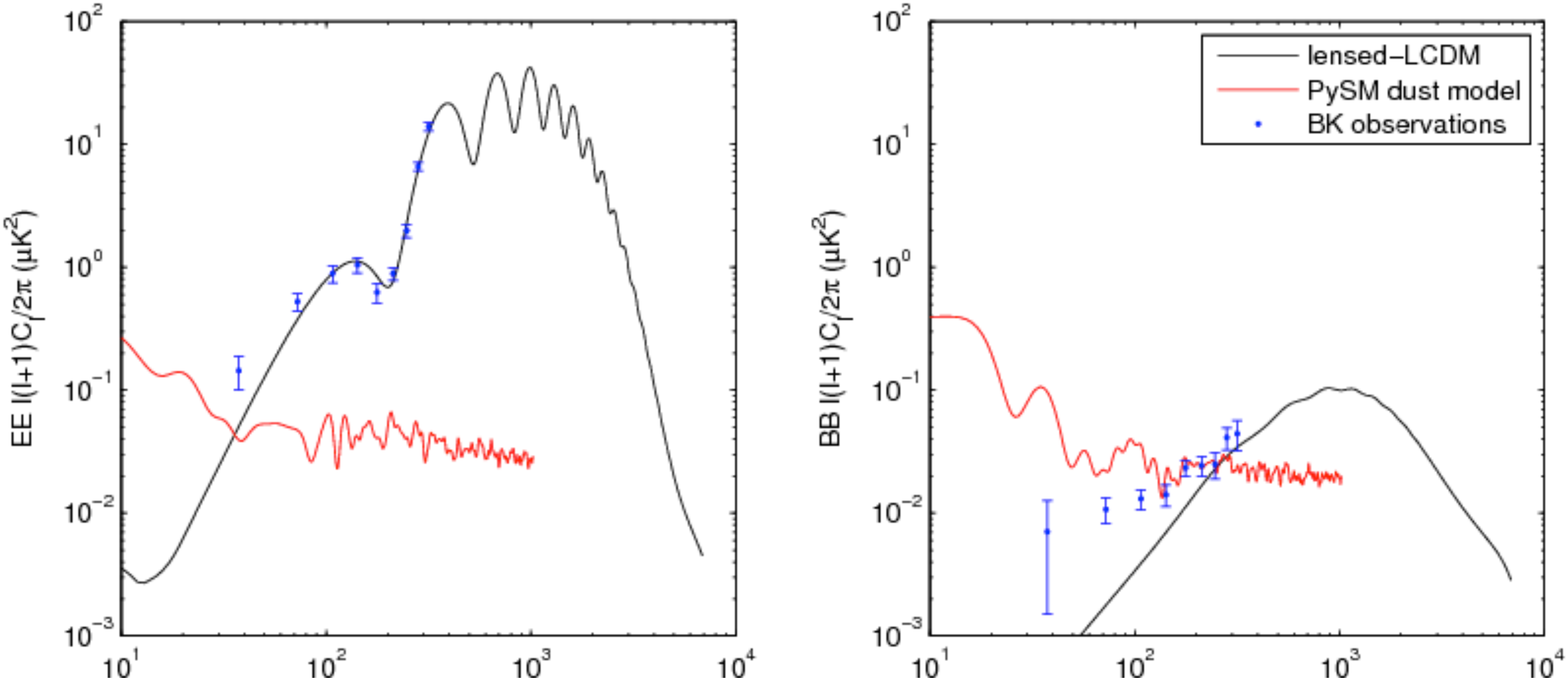
PySM dust model 4 at 155GHz polarized intensity



Color stretch 0 to 5uK

PySM offers several dust models. The noise dominated fine scale structure of the Planck 353GHz map is filtered out and filled back in with a Gaussian realization and the pattern is then extrapolated to other frequencies according to some recipe.

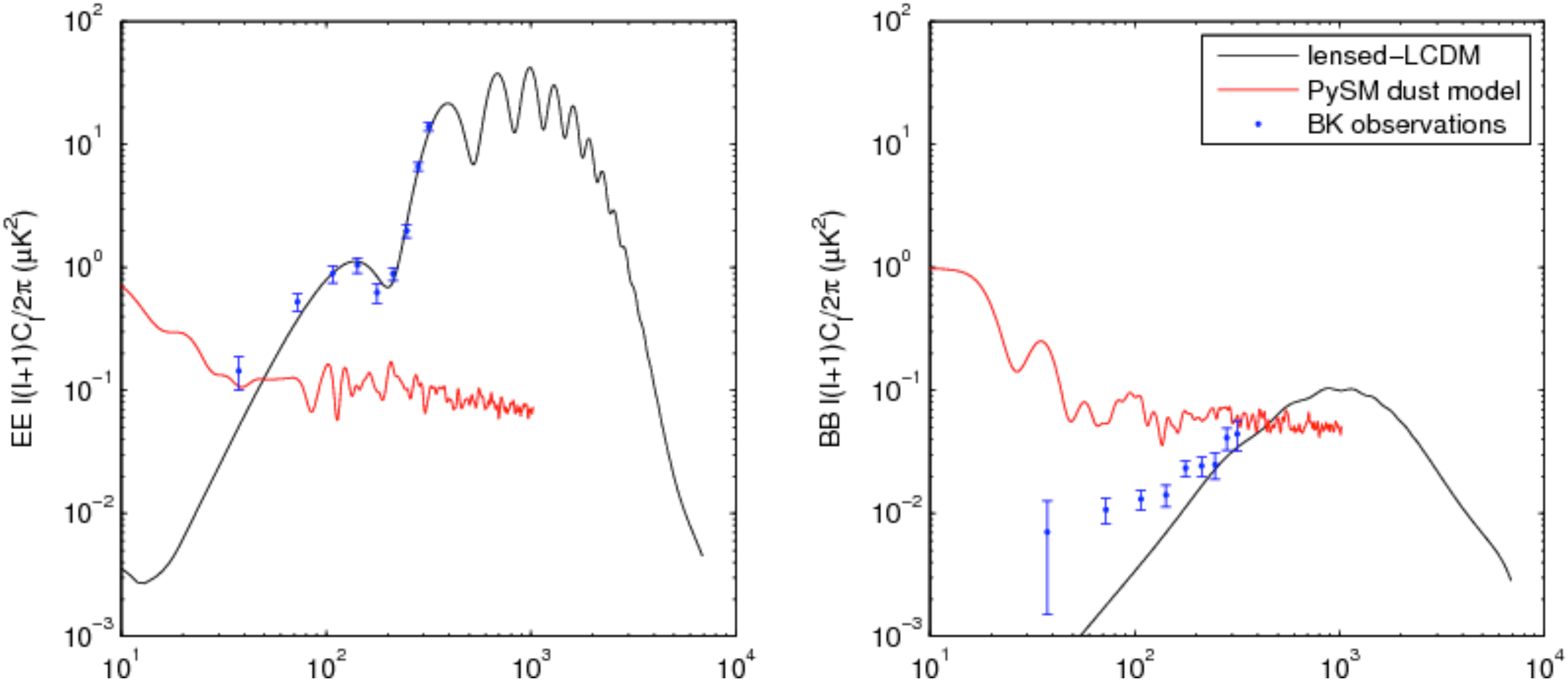
cmbs4_dat/sky_yy/01/pysm_d1_SOS4_155_tophat_map_0512.fits



Take PySM dust model files (provided on NERSC) at 155 GHz and run anafast using public BK14 mask

Compare to public BK14 150 GHz data points

This is PySM dust model 1 - BB power at ell<100 is higher than reality cmbs4_dat/sky_yy/02/pysm_d4_SOS4_155_tophat_map_0512.fits



Take PySM dust model files (provided on NERSC) at 155 GHz and run anafast using public BK14 mask

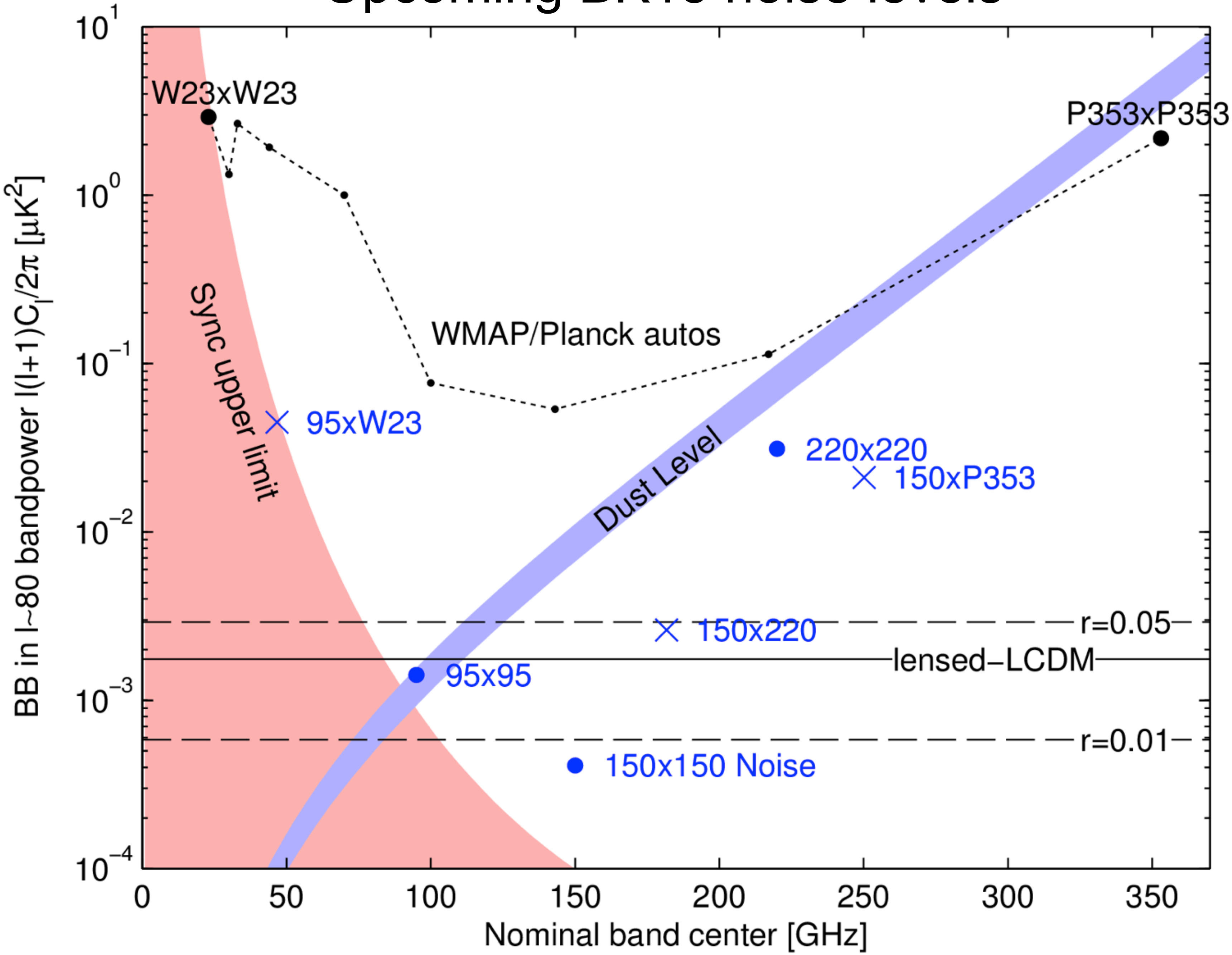
Compare to public BK14 150 GHz data points

This is PySM dust model 4 - BB power at ell<100 is higher than reality - *much higher!*

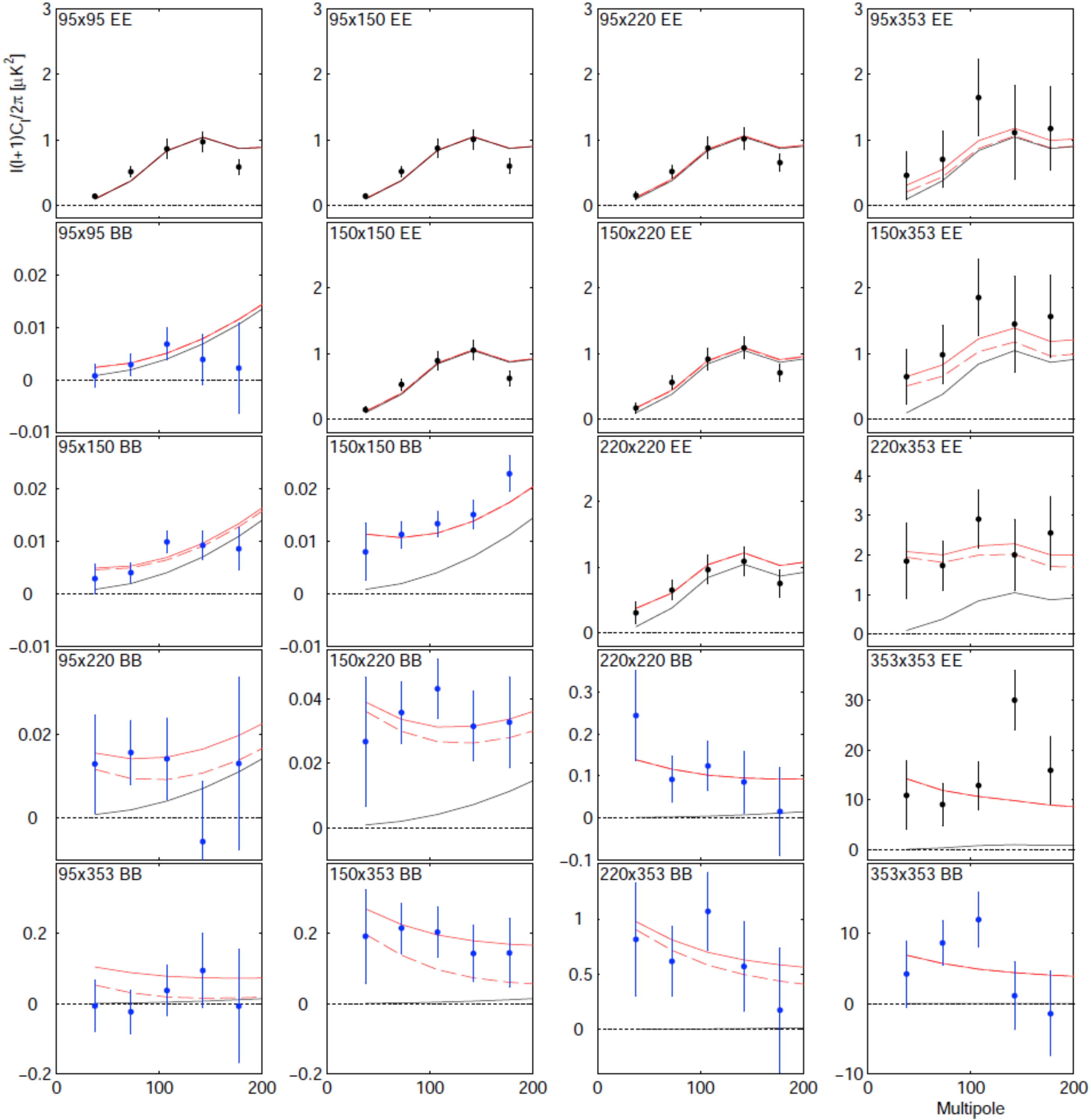
Message 1: a plea...

When constructing sky models check them against the BICEP/Keck data and see if they are consistent with current data in that region of sky (at the available frequencies)

Upcoming BK15 noise levels



Upcoming analysis: BK15 spectra



PIPL paper suggests the dust pattern decorrelates strongly between 217 and 353GHz

We can constrain the strength of decorrelation using BICEP/Keck data

Solid red is BK14 best fit model w. no decorr. – dashed adds decorr. at PIPL level

Messages 2/3:

Additional BICEP/Keck data is incoming and with the BICEP Array 220/270 receiver will be able to probe dust behavior with some precision.

BICEP/Keck data can constrain dust decorrelation and we right now wrestling with the details of how to parameterize this effect – discussion is welcome with those who have thoughts on this.

To search for evidence of decorrelation in our own analysis we add decorrelation of the dust pattern to our parametric model. Following PIPL we define the correlation ratio

$$\mathcal{R}_\ell^{\nu_i \times \nu_j} \equiv \frac{C_\ell(\nu_i \times \nu_j)}{\sqrt{C_l(\nu_i \times \nu_i) C_l(\nu_j \times \nu_j)}}, \tag{1}$$

where $\mathcal{R} < 1$ is decorrelation. To facilitate comparison with PIPL we choose $\mathcal{R}_{80}^{217\times353}$ as the our parameter and scale to other frequencies using

$$f(\nu_0, nu_1) = \frac{(\log(\nu_0/\nu_1))^2}{(\log(217/353))^2} \tag{2}$$

as suggested by PIPL.

Fig. 2 of PIPL suggests that decorrelation grows with increasing ℓ, although in Sec. 4 they assume flat with ℓ. In this paper we investigate several possible scalings

$$g(\ell) = \begin{cases} 1 & \text{flat case} \\ (\ell/80) & \text{linear case} \\ (\ell/80)^2 & \text{quadratic case} \end{cases} \tag{3}$$

Since the ℓ range we are concerned with is not broad this choice turns out to make little practical difference.

The above scalings can easily lead to extreme, and non-physical, behavior for widely seperated frequencies, and low/high ℓ. We therefore re-map the nominal value using the following function

$$\mathcal{R}_\ell^{\nu_i \times \nu_j} = \exp\left[\log(\mathcal{R}_{80}^{217\times353})\, f(\nu_0, \nu_1)\, g(\ell)\right]. \tag{4}$$

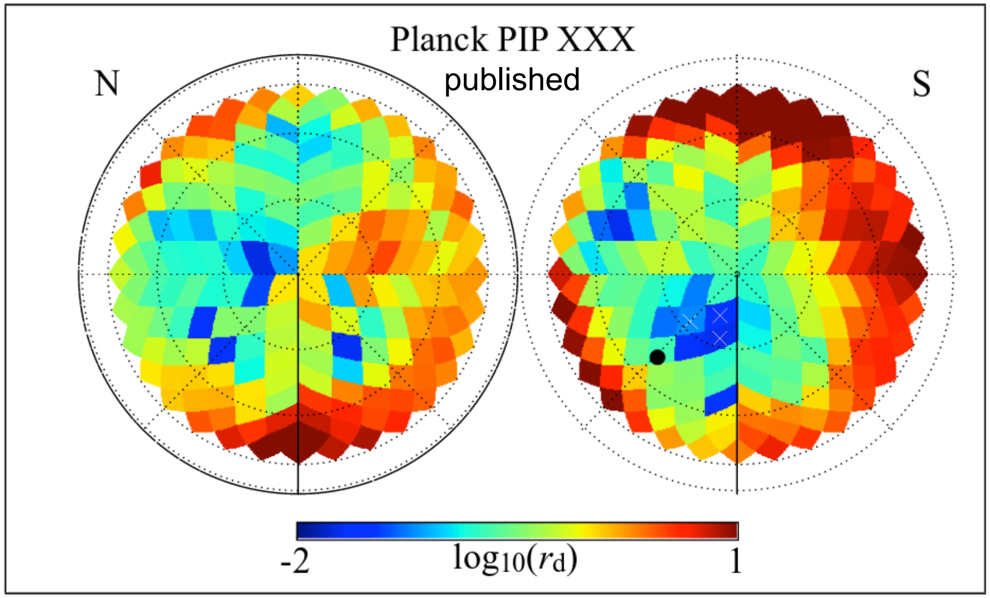
such that $\mathcal{R}$ remains in the range 0 to 1 for all values of f and g. We note that for the frequency scaling this becomes the same as equation 14 of [7] which is shown in that paper to correspond to a Gaussian spatial variation in the foreground spectral index [8].

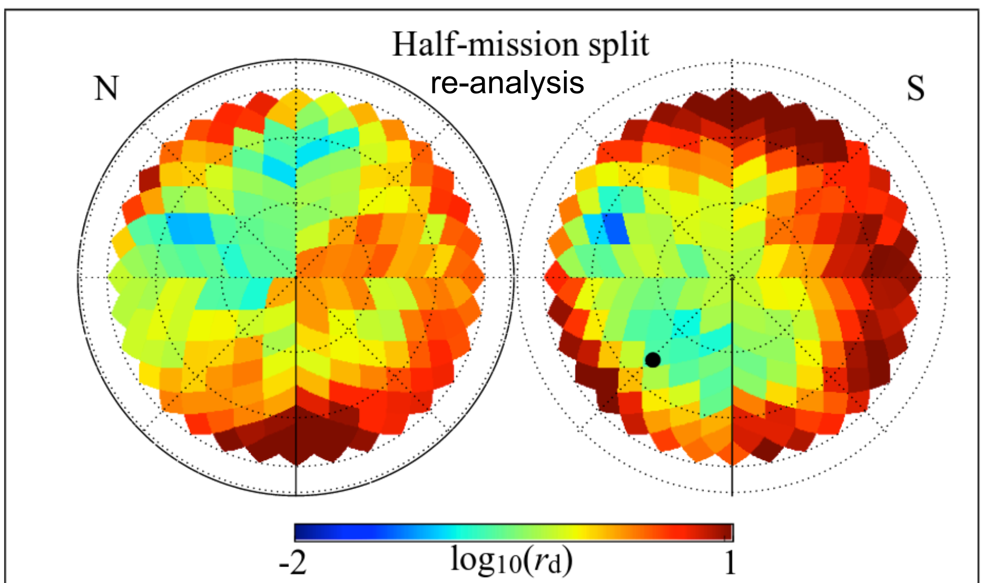
[7] F. Vansyngel, F. Boulanger, T. Ghosh, B. D. Wandelt, J. Aumont, A. Bracco, F. Levrier, P. G. Martin, and L. Montier, ArXiv e-prints (2016), arXiv:1611.02577.

[8] For some purposes we do want to consider non-physical values $\mathcal{R}_{80}^{217\times353} > 1$ and in order to do this in a symmetrical manner we use $\mathcal{R}_\ell^{\nu_i \times \nu_j} = 2 - \exp\left[\log(2 - \mathcal{R}_{80}^{217\times353})\, f(\nu_0, \nu_1)\, g(\ell)\right]$.

Backup slides

Is there a cleaner small field than the BICEP field?





- The Planck 353GHz Q/U maps hit their noise floor in the cleanest regions
  - From this data it is not really possible to tell if there are cleaner small regions than the BICEP/Keck field
- When we attempt to reproduce the Planck PIPXXX analysis we find that the apparent cleaner regions shift around depending on the data split selected
- The BK patch is currently the only low dust field where we actually know the dust level!