A new model of the microwave polarized sky for CMB experiments

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Total sky model in polarization

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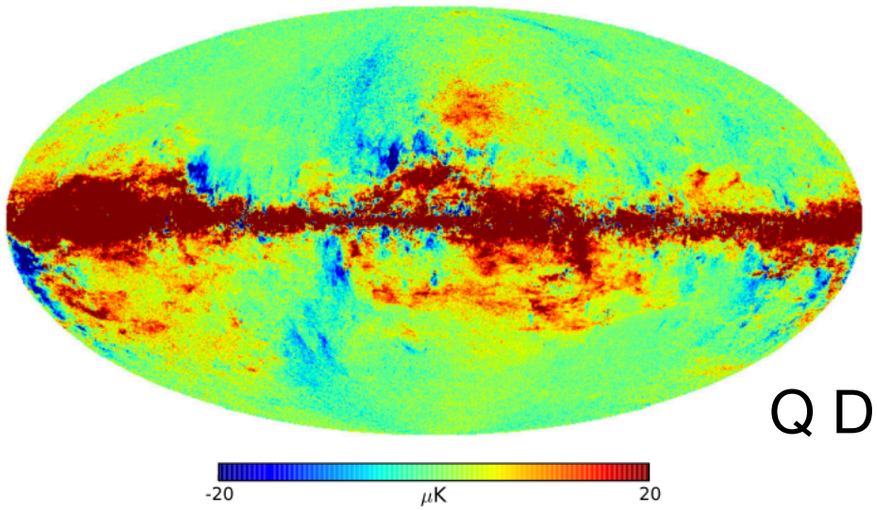
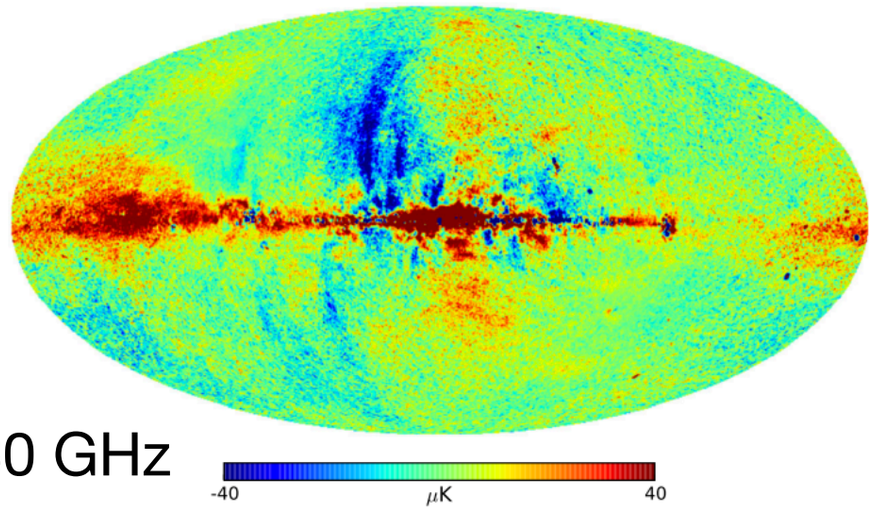
Our model includes:

- Thermal dust
- Synchrotron
- Anomalous Microwave Emission (AME)

- White noise realization
- CMB realization



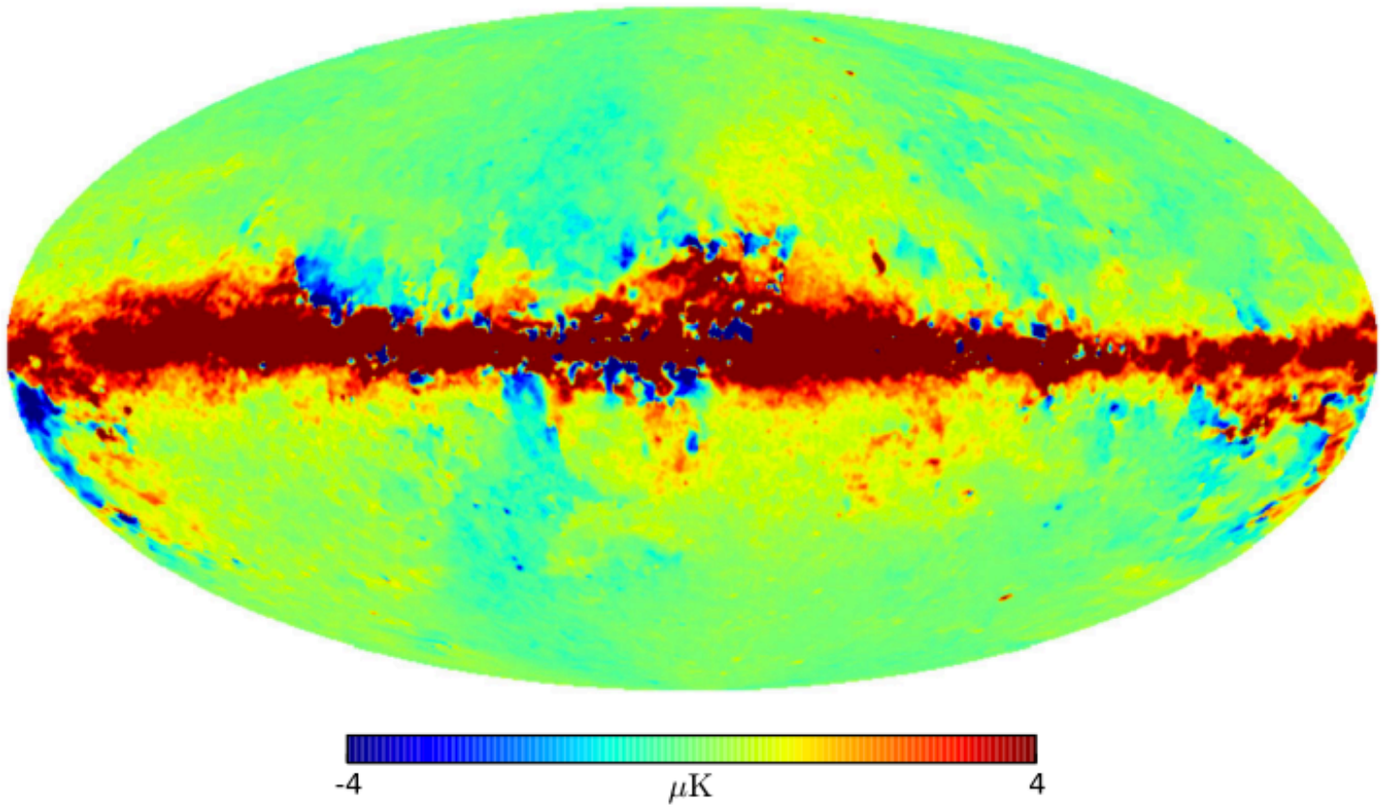
Q Dust at 30 GHz



Q Syn at 30 GHz

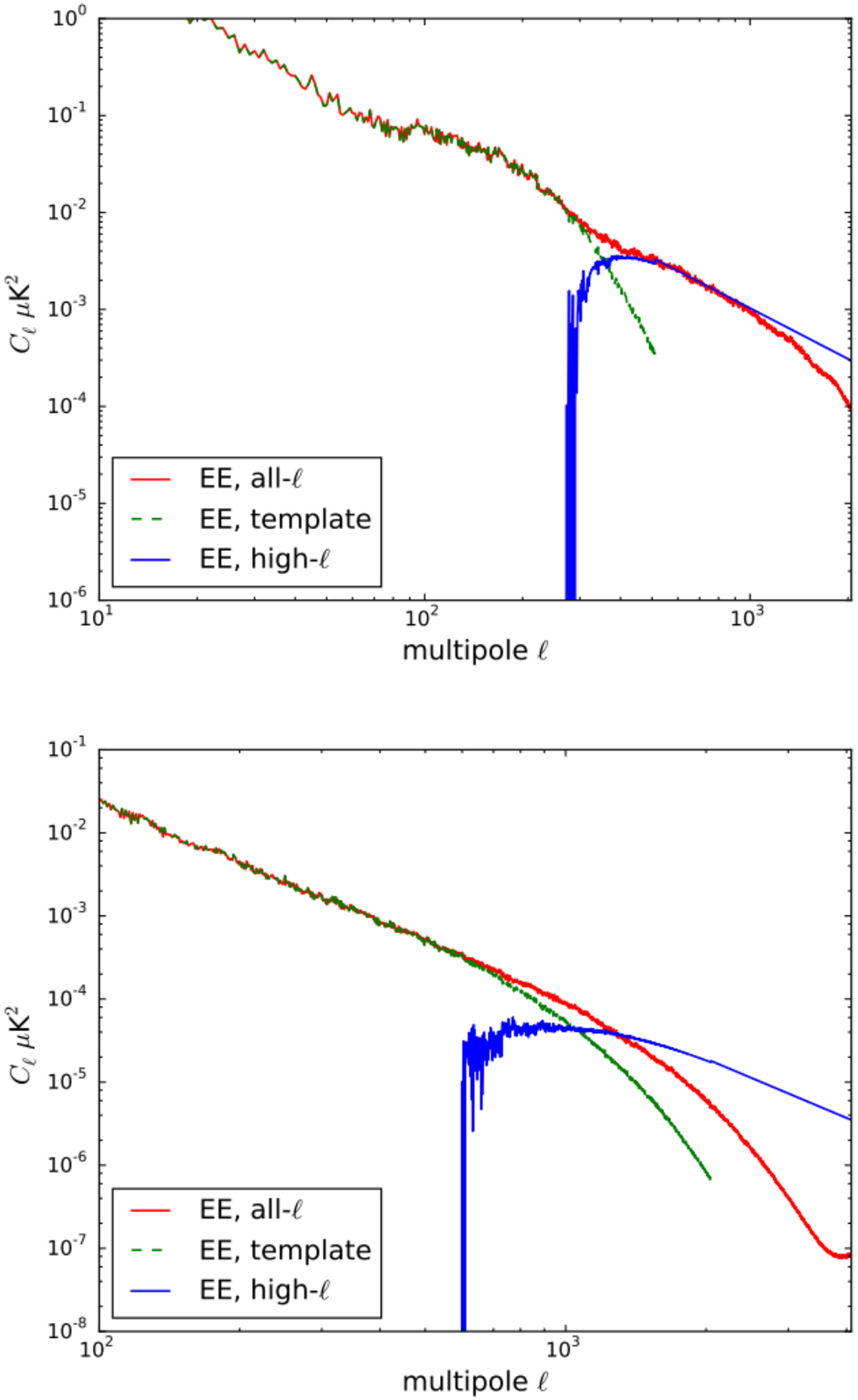
Templates are from 2015 Planck data release (Planck collaboration 2016 X)

Anomalous Microwave Emission template



Template constructed using thermal dust pol angles and AME T template with f_{pol}=0.01

Small scale features creation



- We extrapolate the angular power spectrum to higher multipoles, with a power-law fit.
- Then, create a map and weight it with a “Galactic mask”, the intensity of the template

- Dust and AME features are created with the same random seed.

Spectral Energy Distributions

We consider standard and more complicated SEDs

Synchrotron

$$T_{\mathrm{A,syn}}(\nu) \propto \nu^{-\beta_{\mathrm{syn}}}$$

$$T_{\mathrm{A,syn}}(\nu) \propto (\nu/\nu_0)^{-\beta_{\mathrm{syn}}+C\,\log(\nu/\nu_{\mathrm{piv}})}$$

Dust

$$T_{\mathrm{A,dust}}(\nu) \propto \nu^{\beta_{\mathrm{dust}}+1}[\exp(h\nu/kT_{\mathrm{d}}) - 1]^{-1}$$

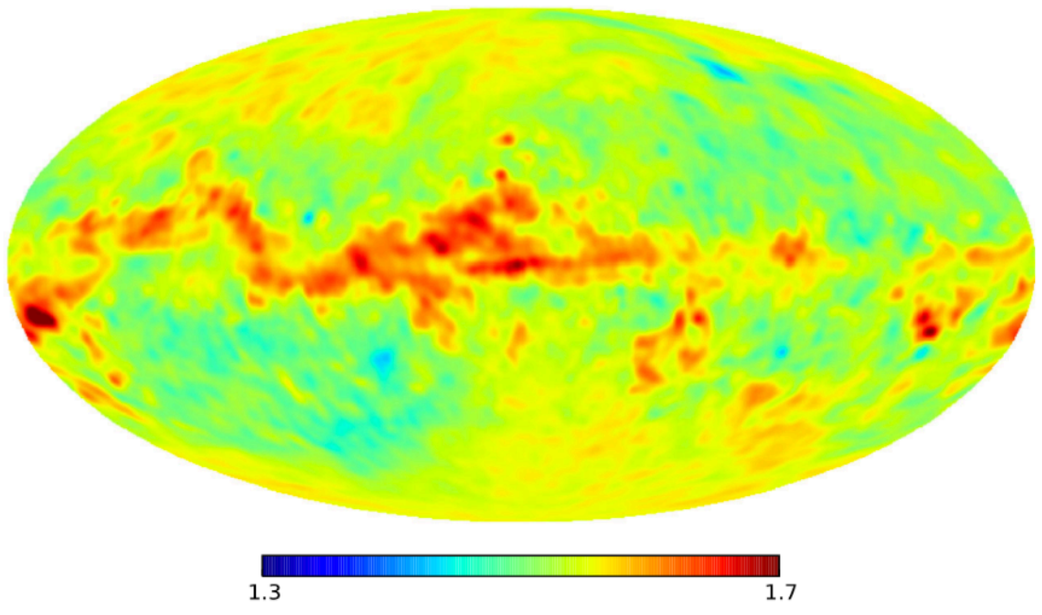
$$T_{\mathrm{A,dust}}(\nu) \propto \sum_{\mathrm{i}=1}^{N_{\mathrm{mbb}}} E_{\mathrm{dust,i}}\, \nu^{\beta_{\mathrm{dust,i}}+1}[\exp(h\nu/kT_{\mathrm{d,i}}) - 1]^{-1}$$

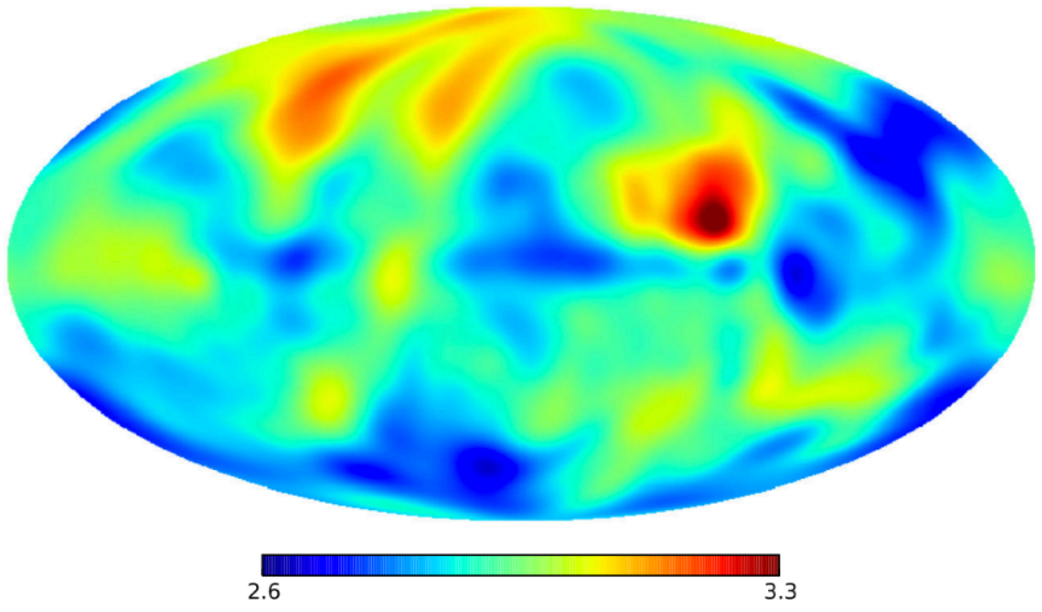
AME (from Bonaldi+07)

$$\log(T_{\mathrm{A},\nu}) = \mathrm{const.} - \left[\frac{m_{60}\log(\nu_{\mathrm{max}})}{\log(\nu_{\mathrm{max}}/60\,\mathrm{GHz})} + 2\right]\log(\nu)$$

$$+ \frac{m_{60}}{2\log(\nu_{\mathrm{max}}/60\mathrm{GHz})}(\log(\nu))^2,$$

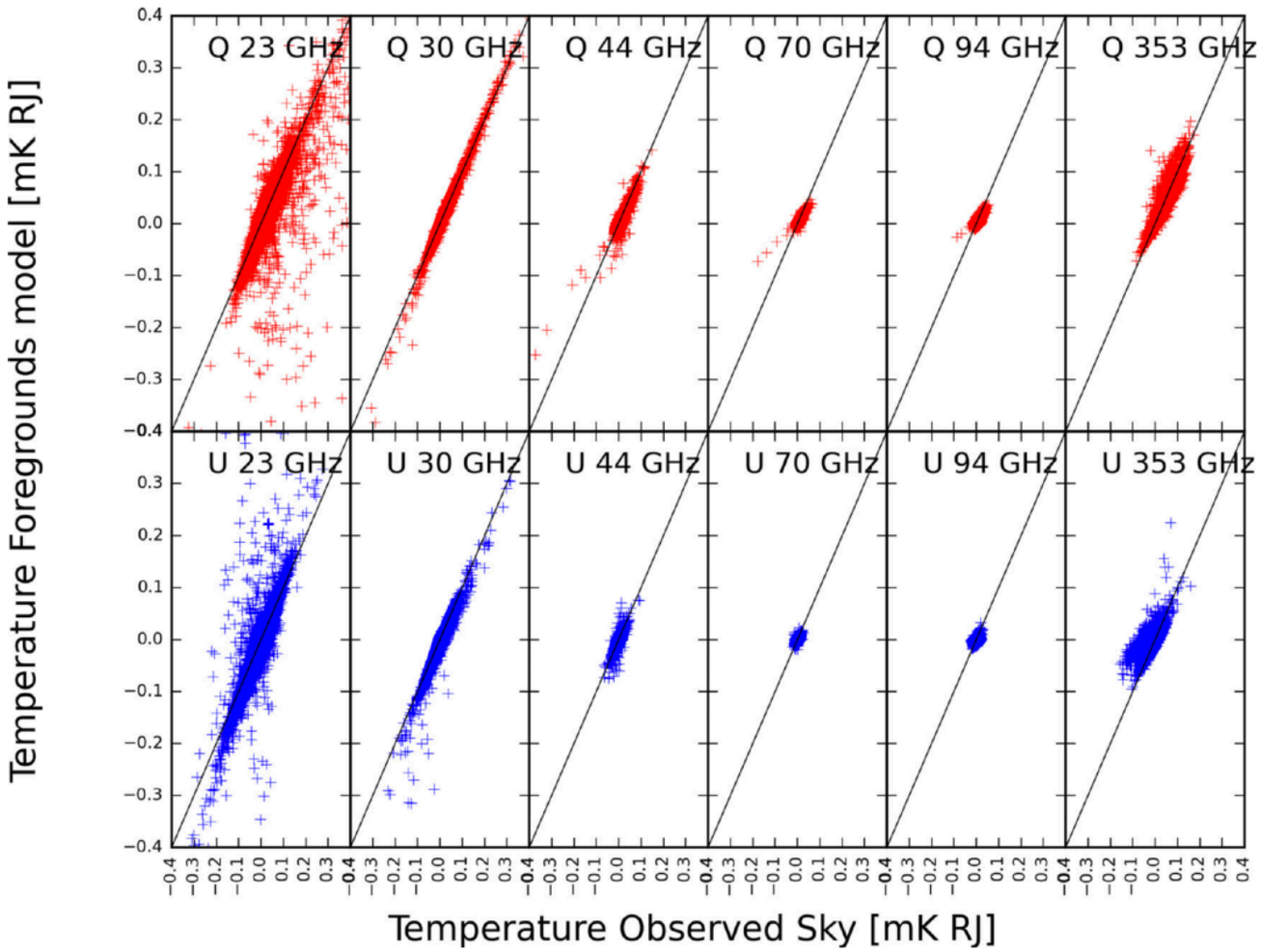
β_{dust} map from Planck+16



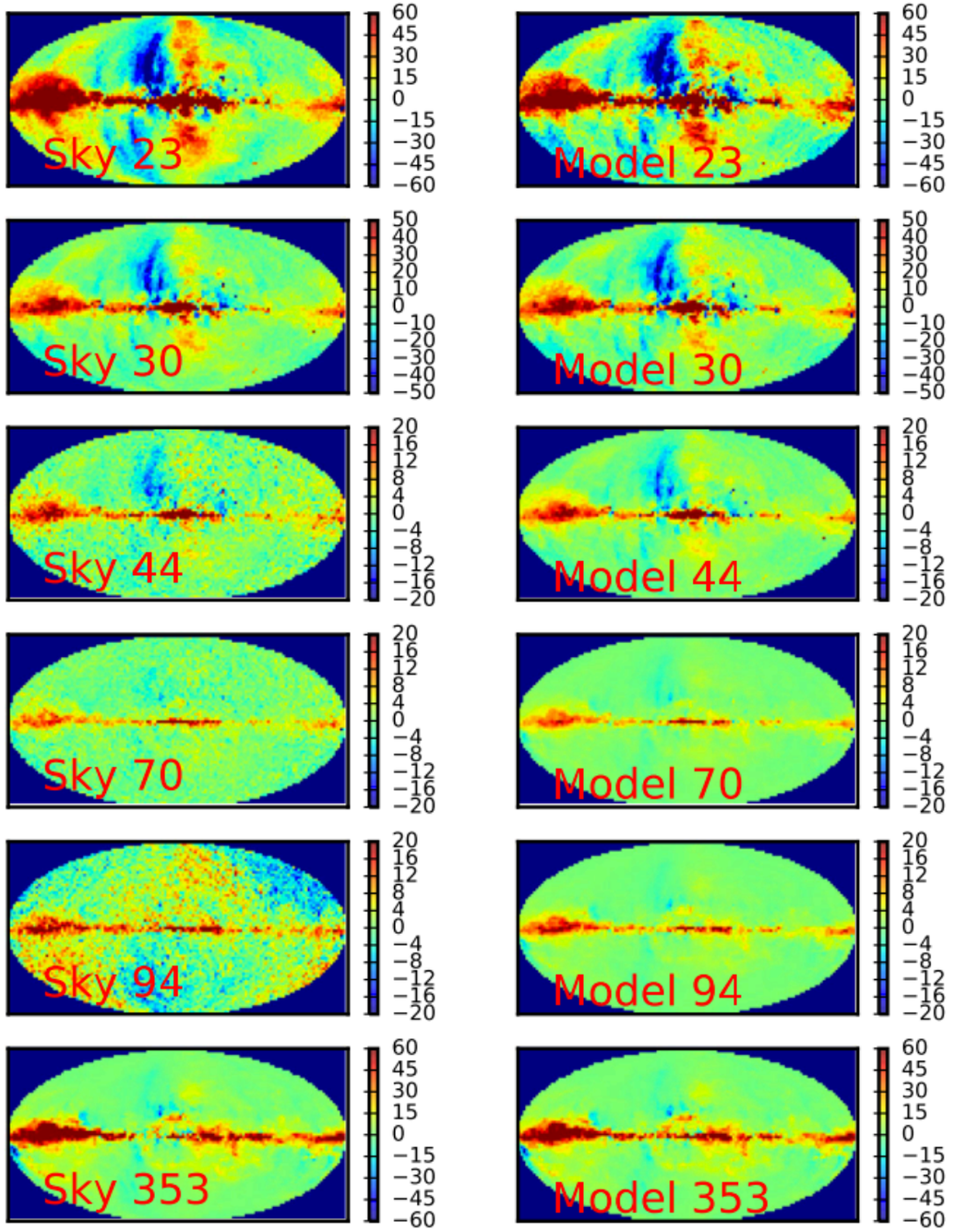


β_{syn} map from Giardino+02

Comparison of maps: Planck and WMAP bands

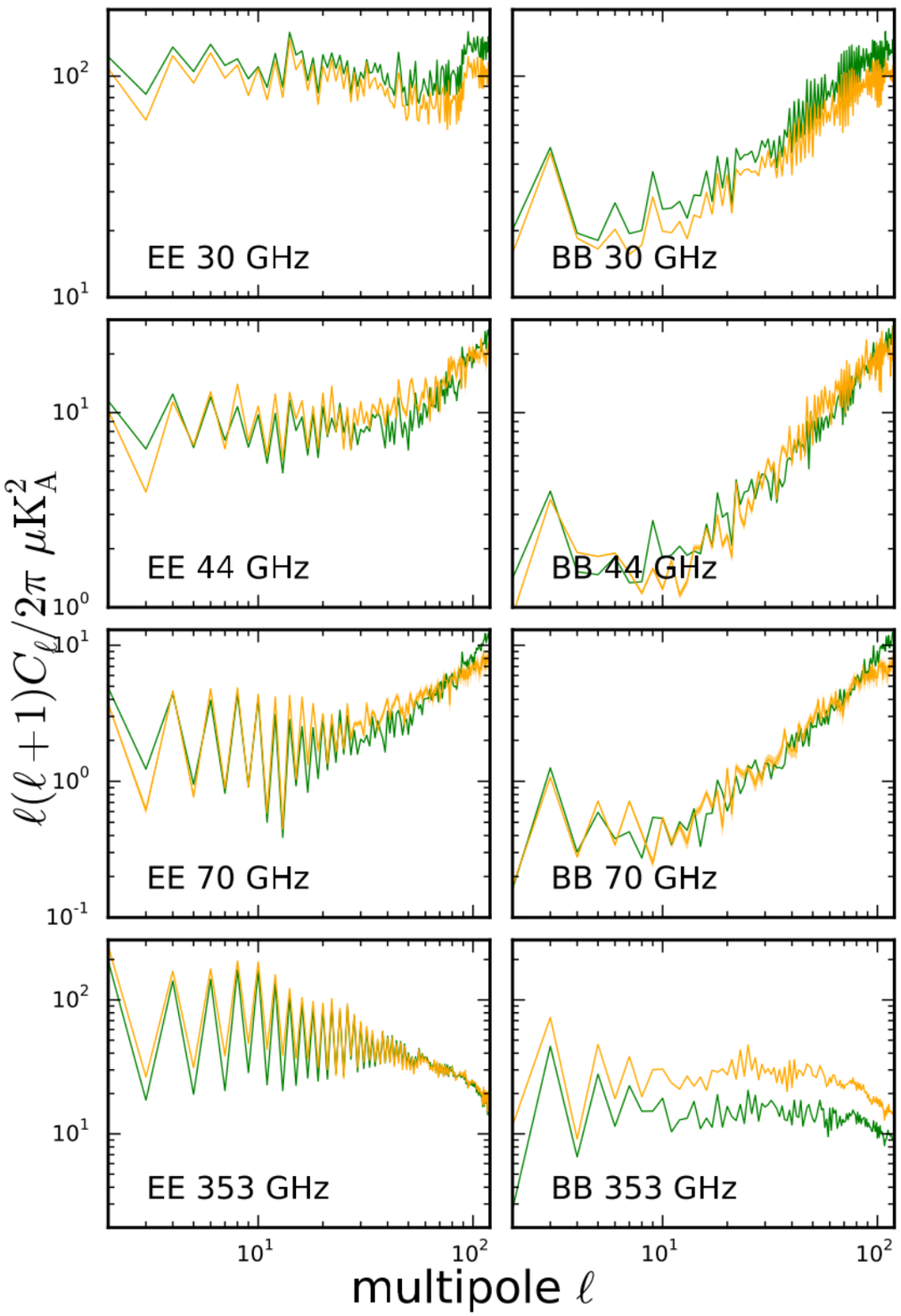


Model vs. Observations:
Pixels within |b| <= 20 deg

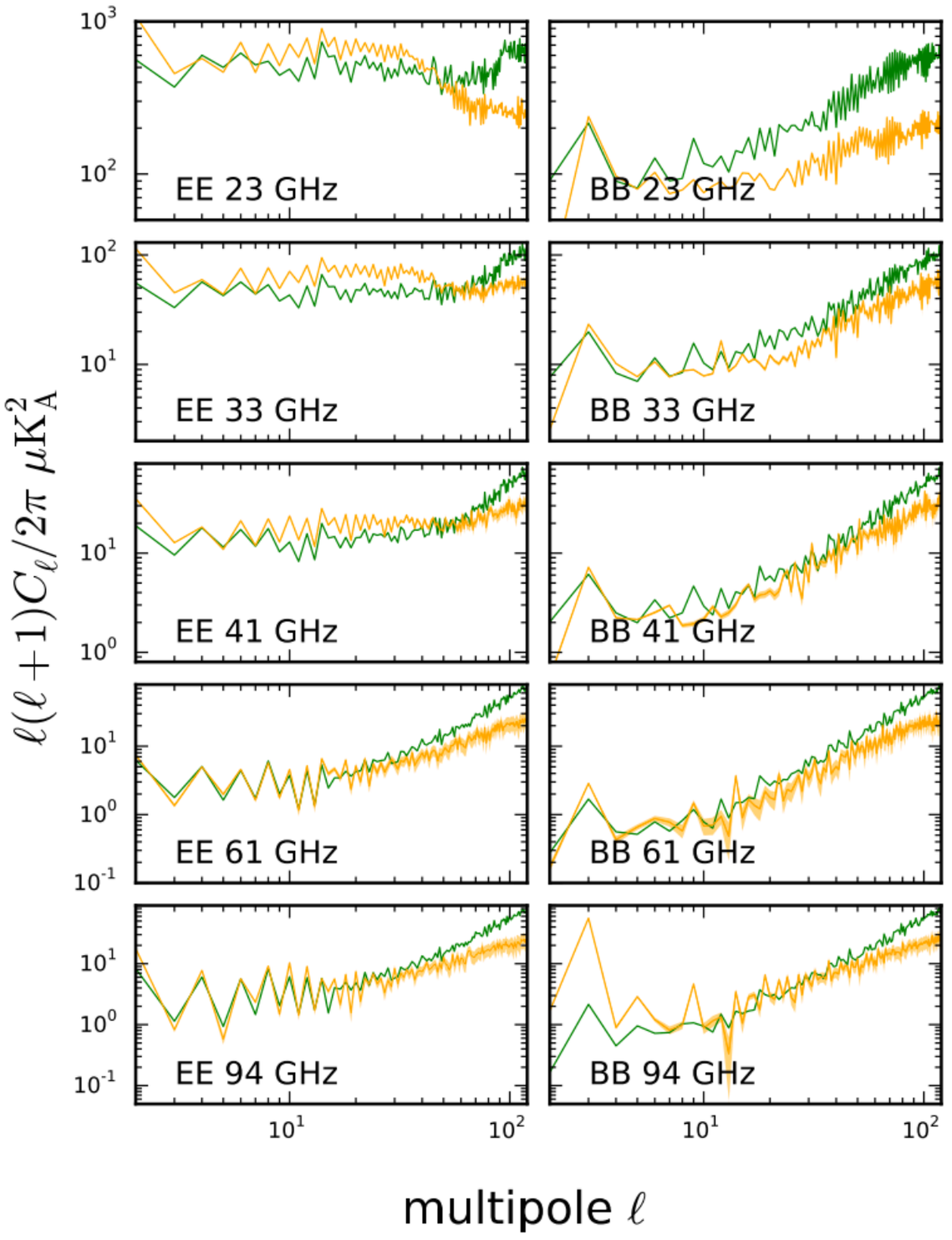


Model vs. Observations:
Q maps

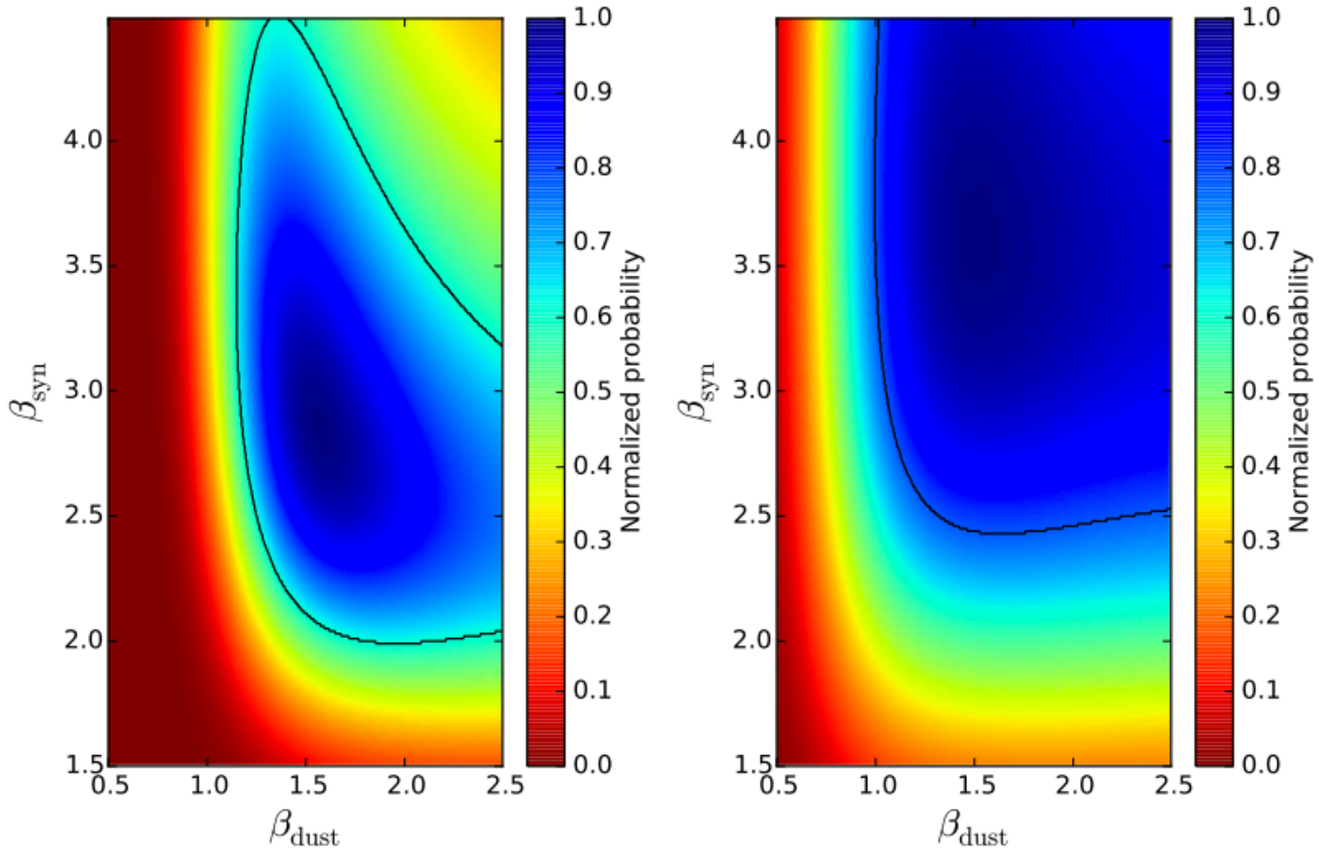
Comparison of C_ℓ: Planck and WMAP bands



Planck

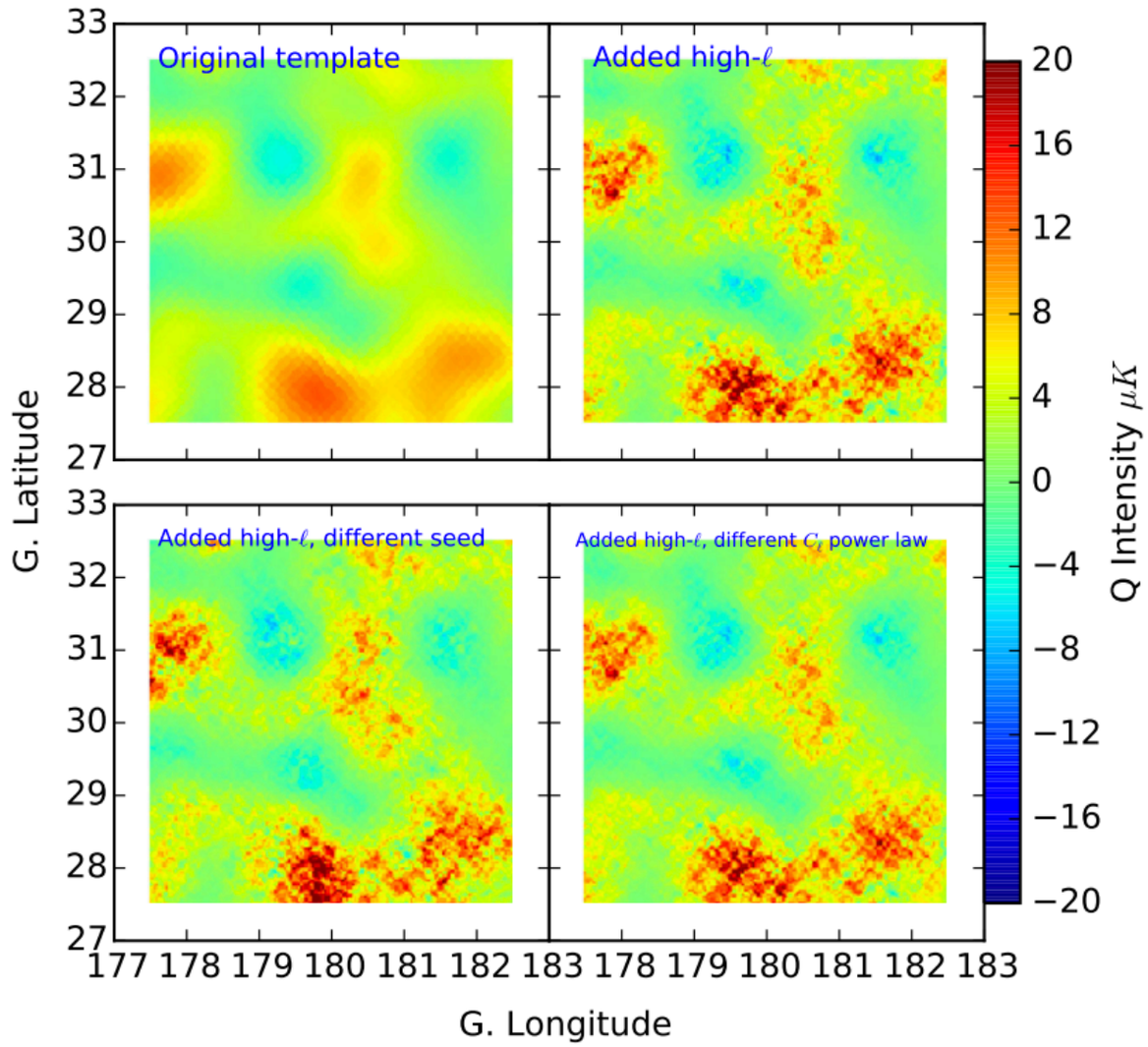


WMAP



Baseline spectral parameters β_{syn}=3.1 β_{dust}=1.53 is the best fit. A range of values are also a good fit.

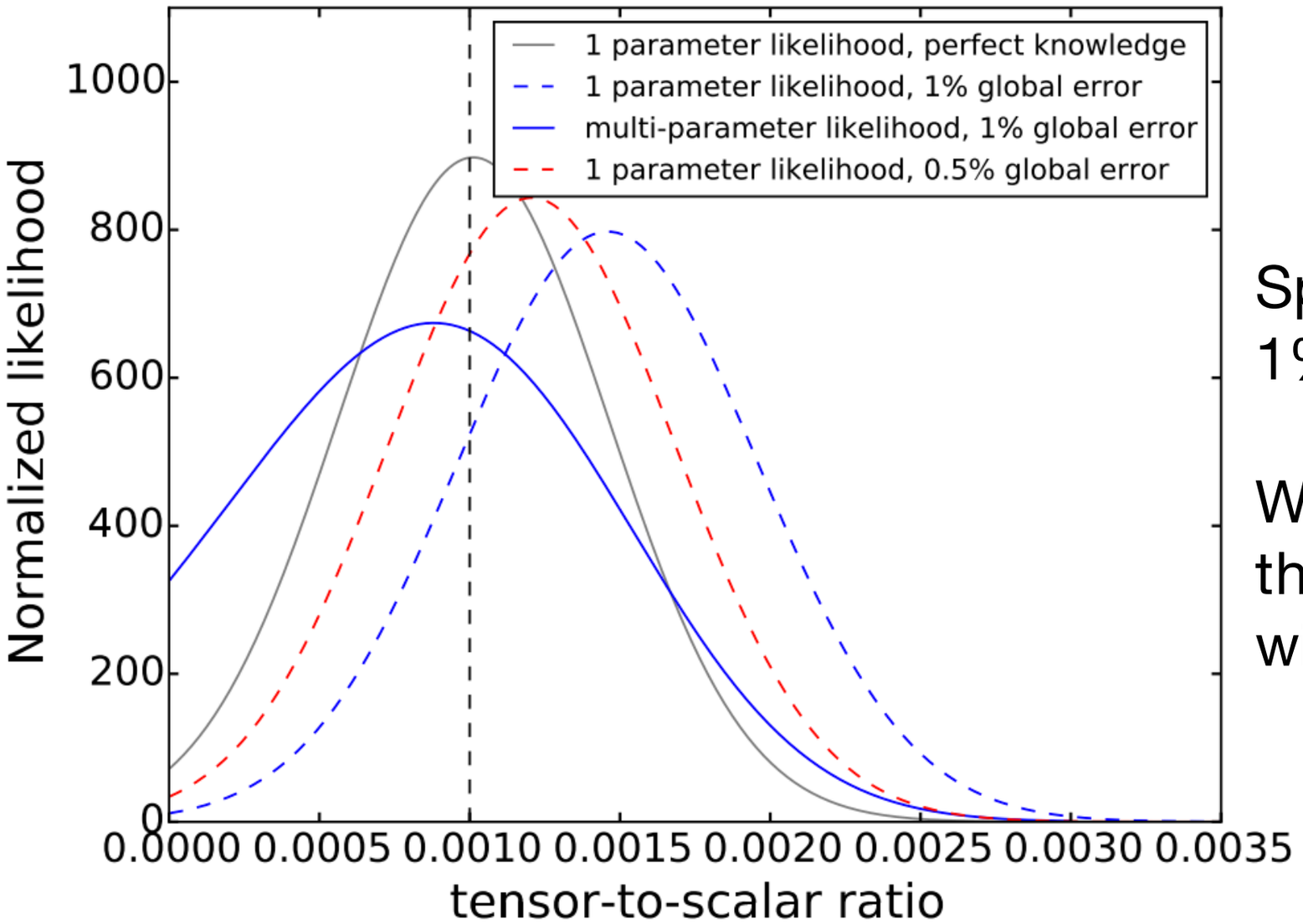
Example of randomization, for Monte Carlo purposes. Section of Synchrotron template



Study for COrE proposal

MNRAS 468, 4408 (2017)

Using the sky model, we produce a **forecast study for *r***, for example future experiment.



Spatially variable βs indices, 1% global error is biased.

We model the foregrounds in the likelihood. This helps with the bias.

Summary

- Sky model in polarization. Includes foregrounds:
  - Thermal dust
  - Synchrotron
  - AME
- Creation of random small-scale features for all foregrounds. The specifics can be controlled for Monte Carlo purposes.
- The model is a good match with the observed polarized sky.
- In a follow-up work, the model is used to simulate observations and forecast performance on *r*.