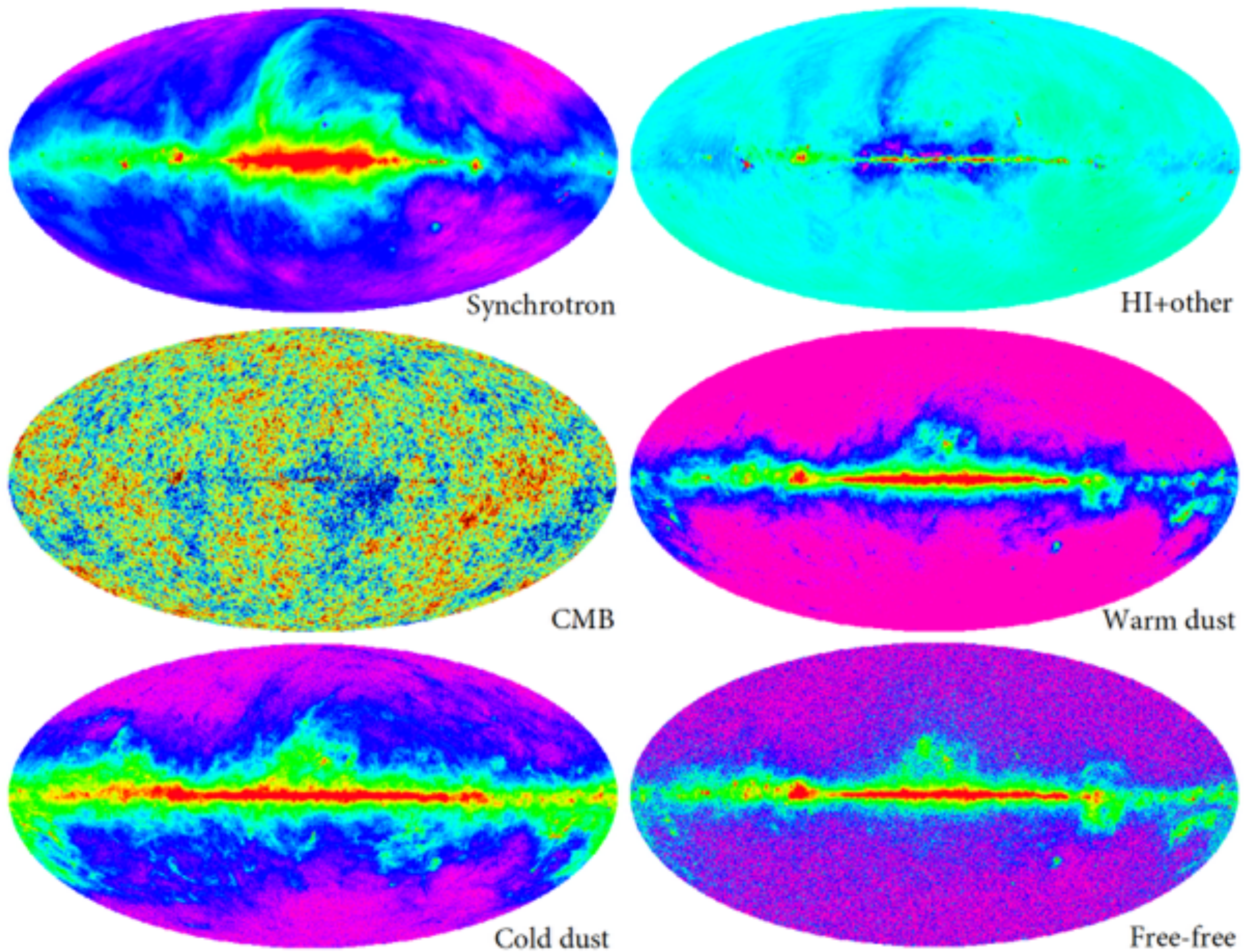
The extended Global Sky Model (eGSM)

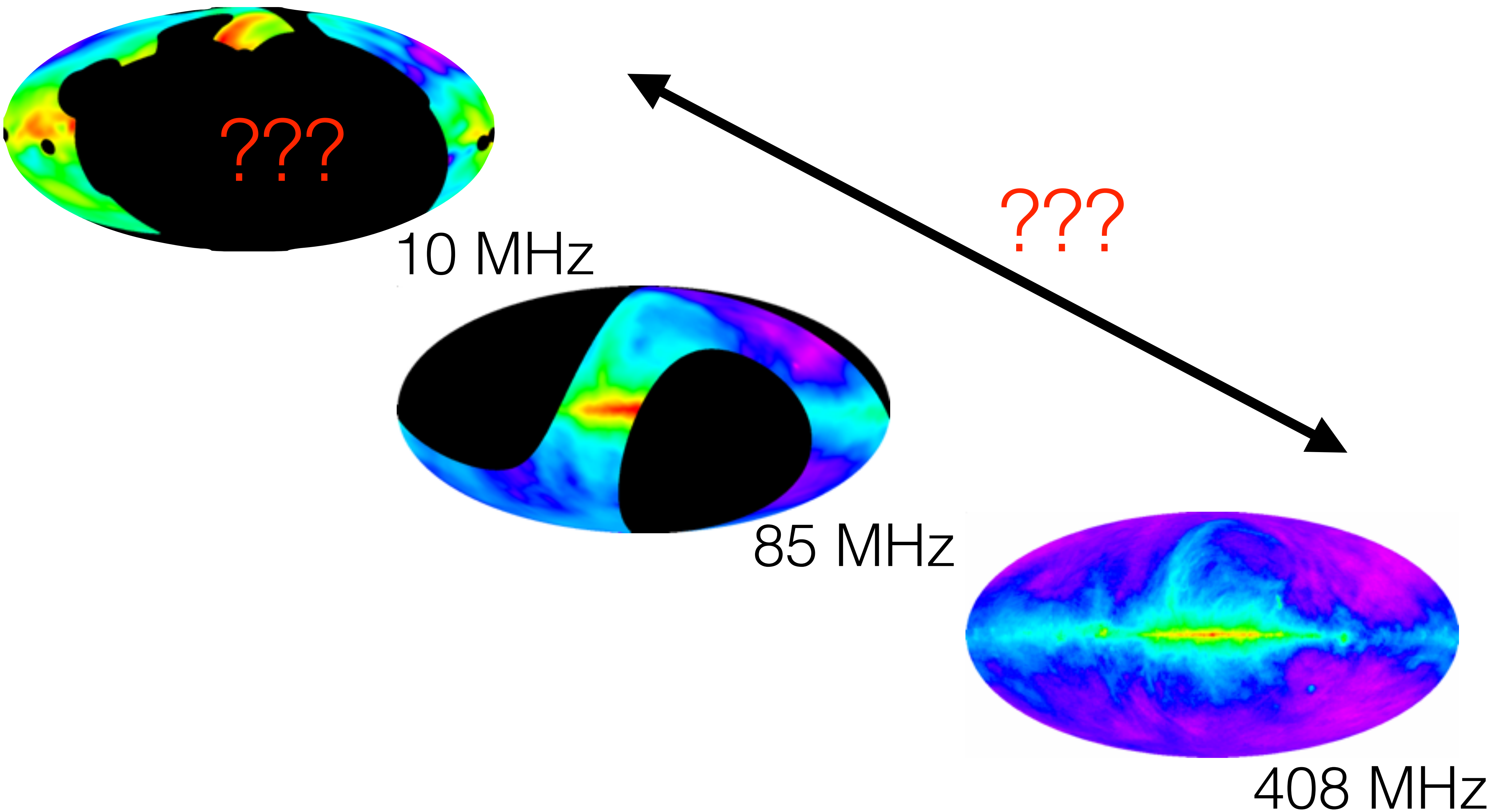


Adrian Liu, Hubble Fellow, UC Berkeley

The extended Global Sky Model (eGSM) project

Adrian Liu, UC Berkeley
Aaron Parsons, UC Berkeley
Doyeon "Avery" Kim, UC Berkeley
Josh Dillon, UC Berkeley
Eric Switzer, NASA Goddard
Max Tegmark, MIT
Haoxuan "Jeff" Zheng, MIT/Intel

What does the sky look like in all directions at “all” frequencies?

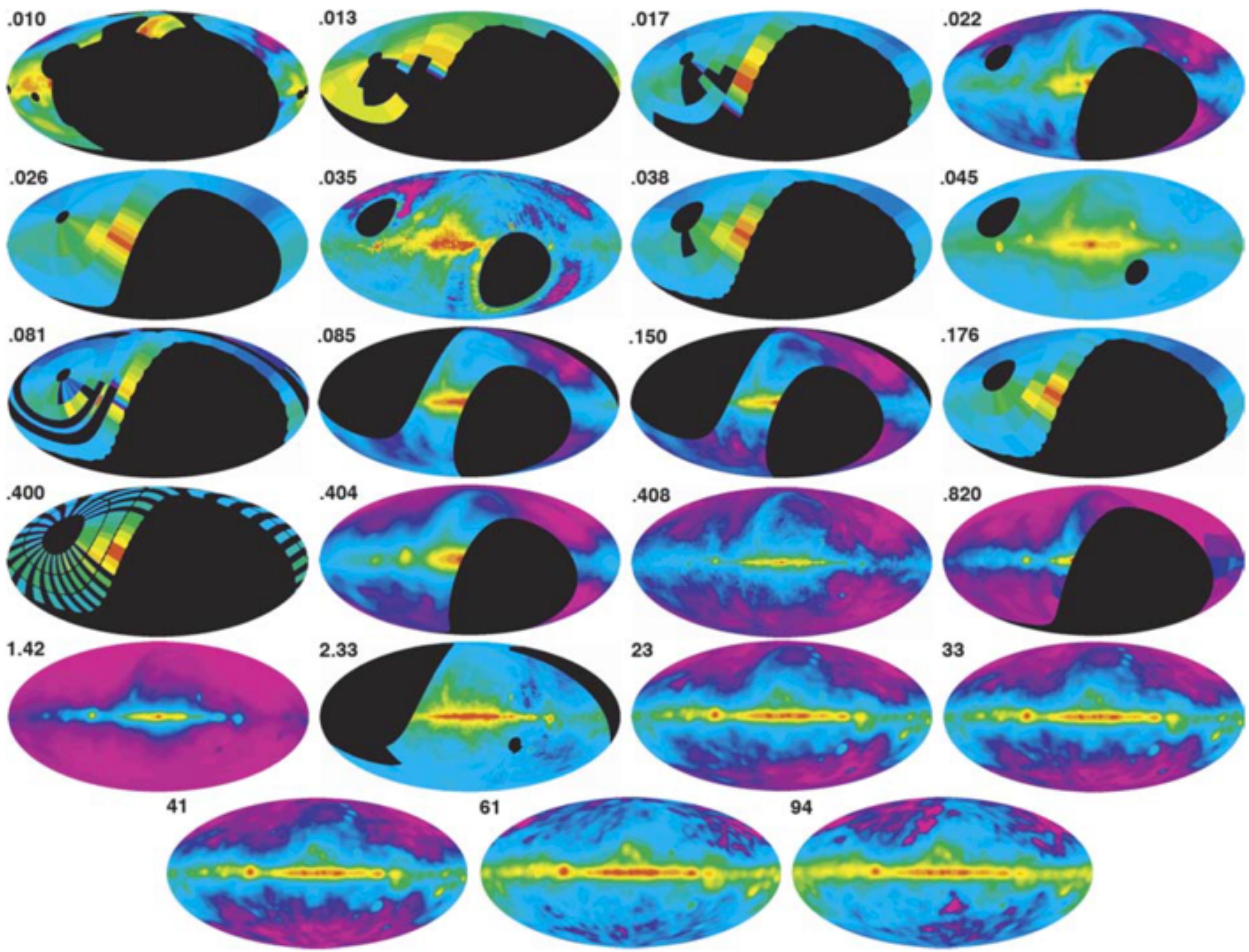


How does one model the sky?

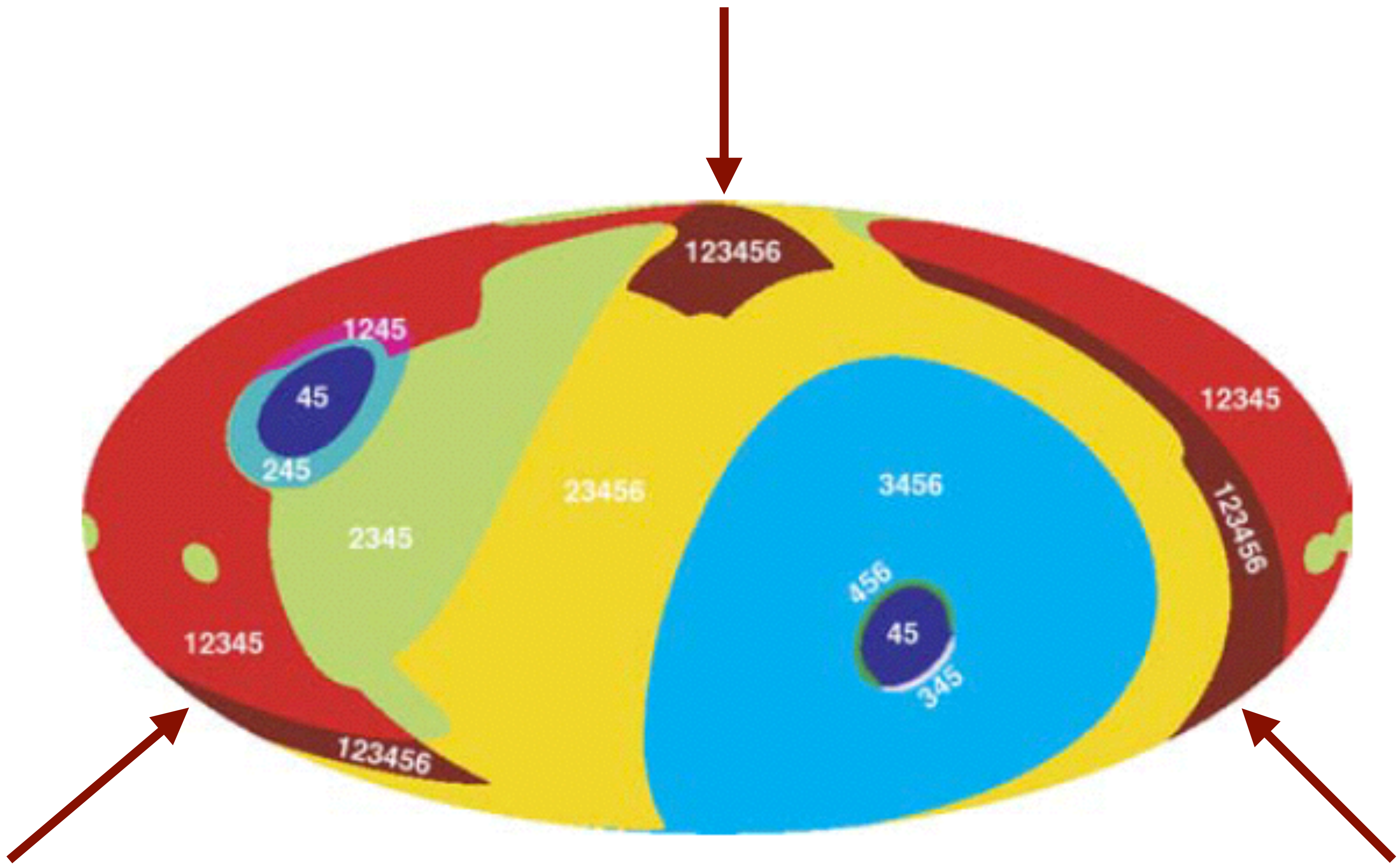
Global Sky Model v1

(de Oliveira-Costa et al. 2008, MNRAS 388, 247)

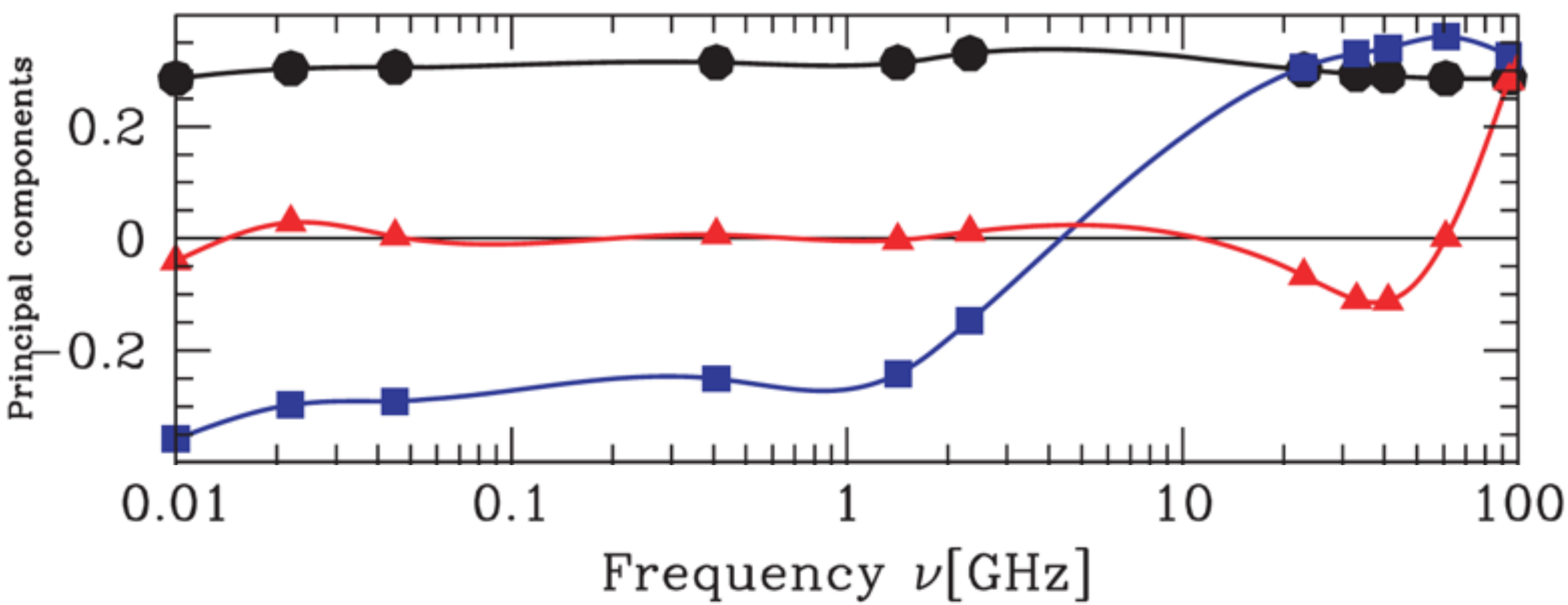
Take a wide selection of survey data…



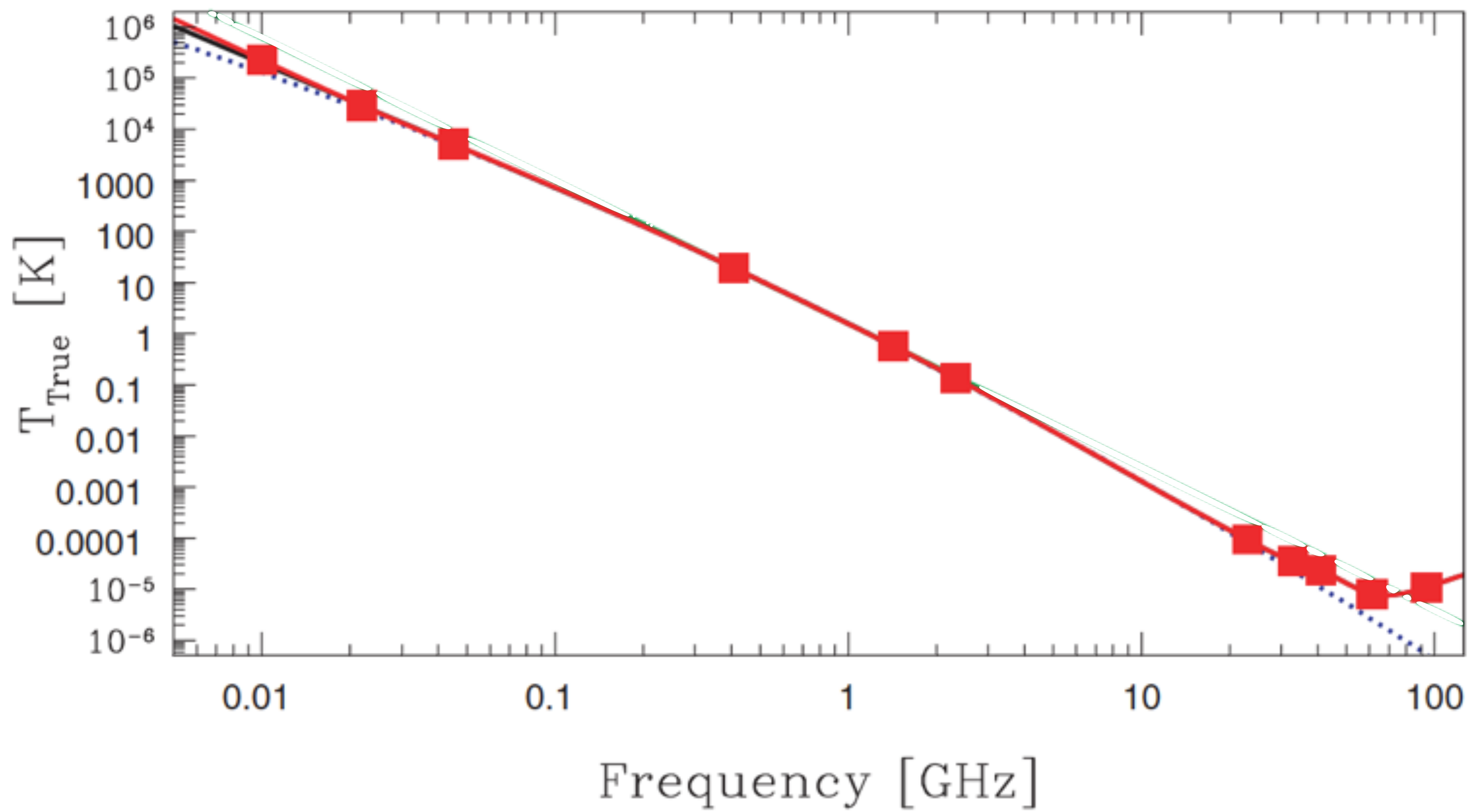
…identify common regions…



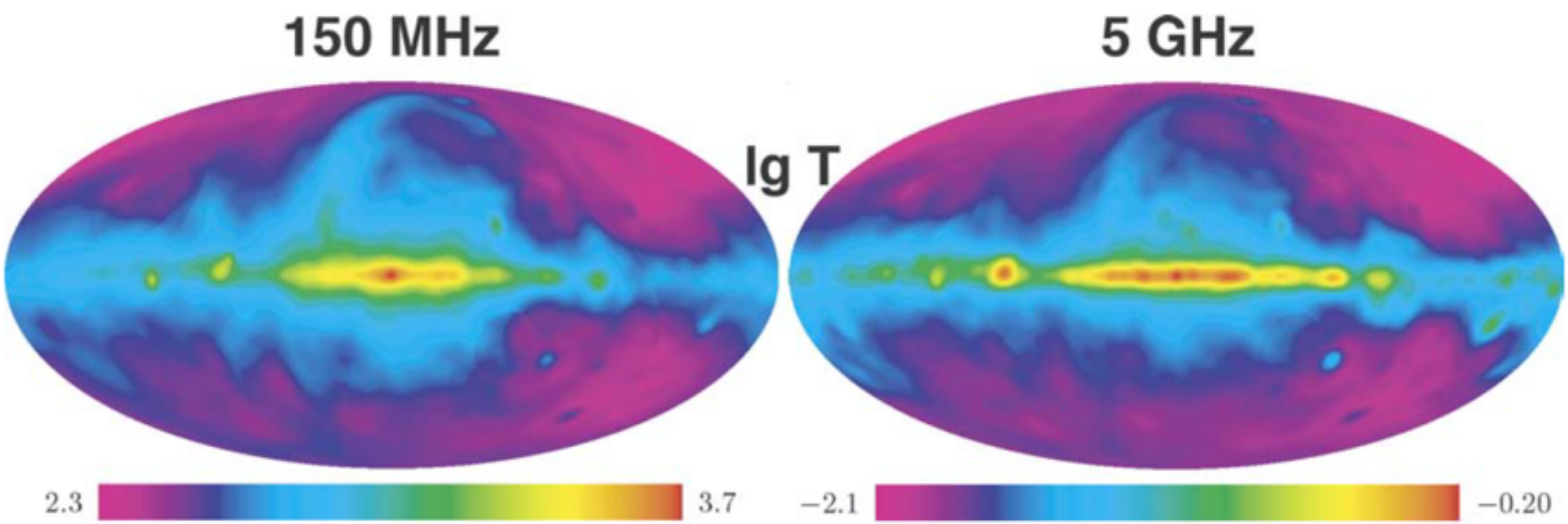
…which are then used to train three principal component spectral templates…



…that are used to fit the spectra in every pixel of the sky…



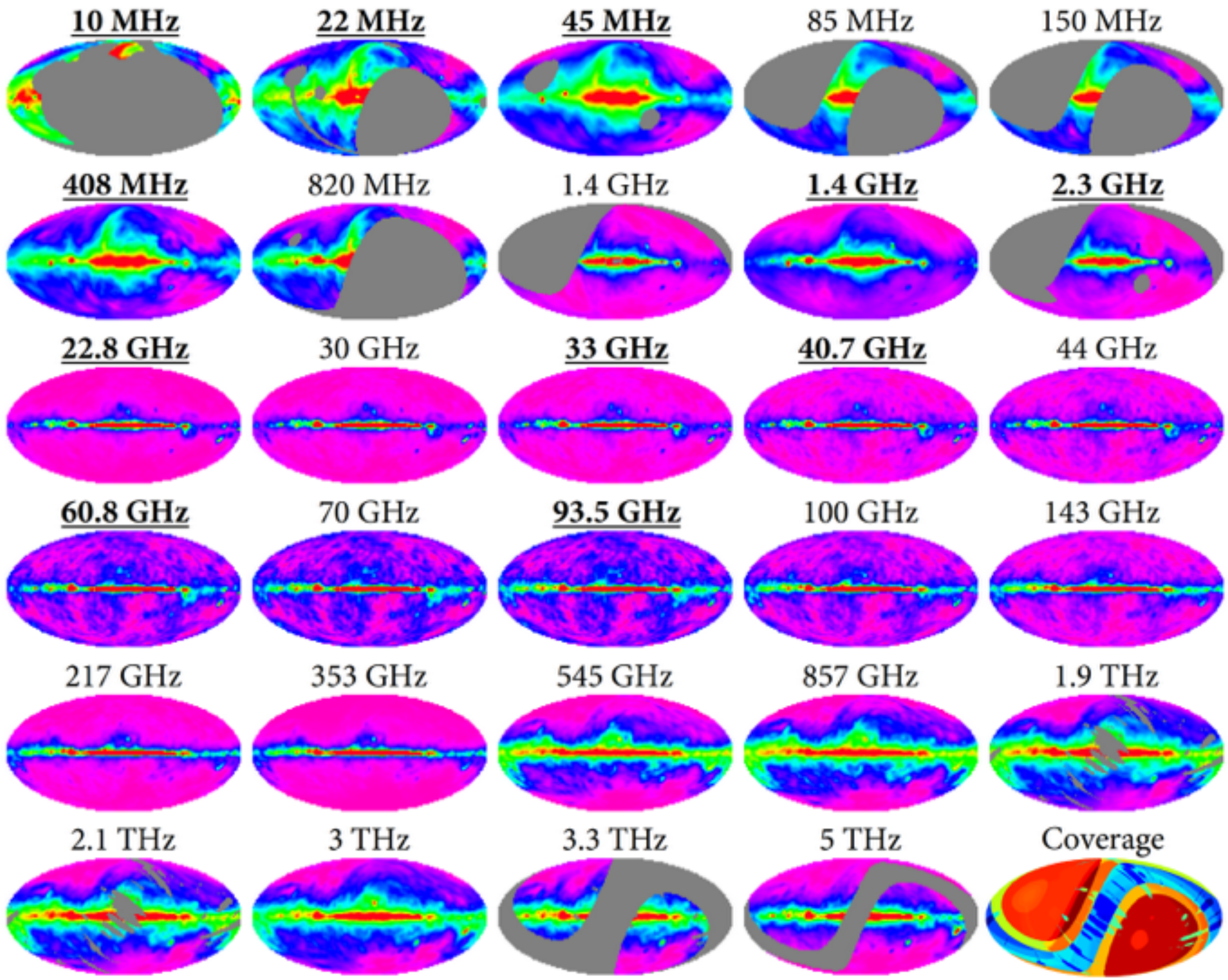
…and are interpolated to produces maps of the sky at "any" frequency



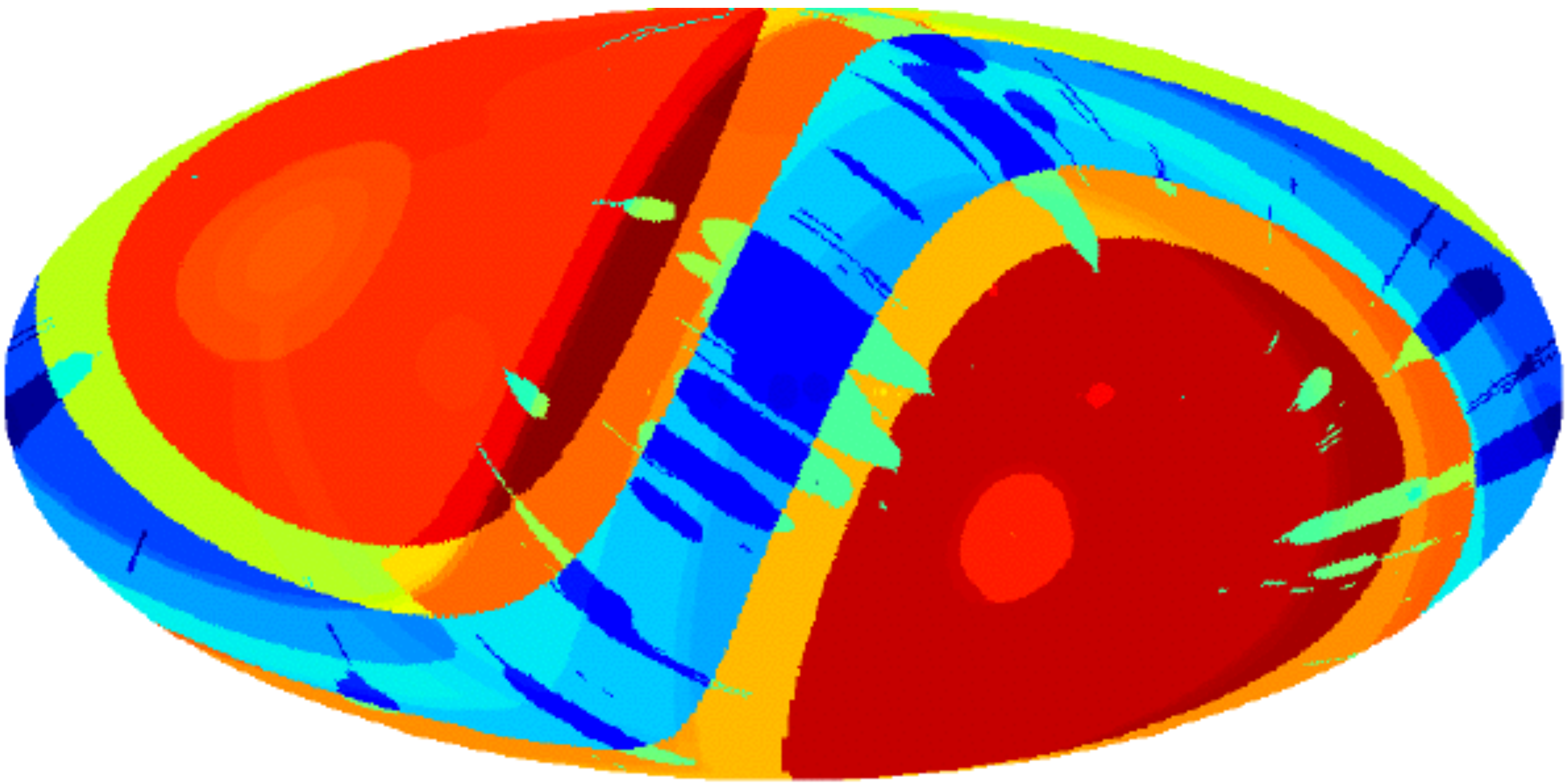
Global Sky Model v2

(Zheng… **AL**… et al. 2017, MNRAS 464, 3486)

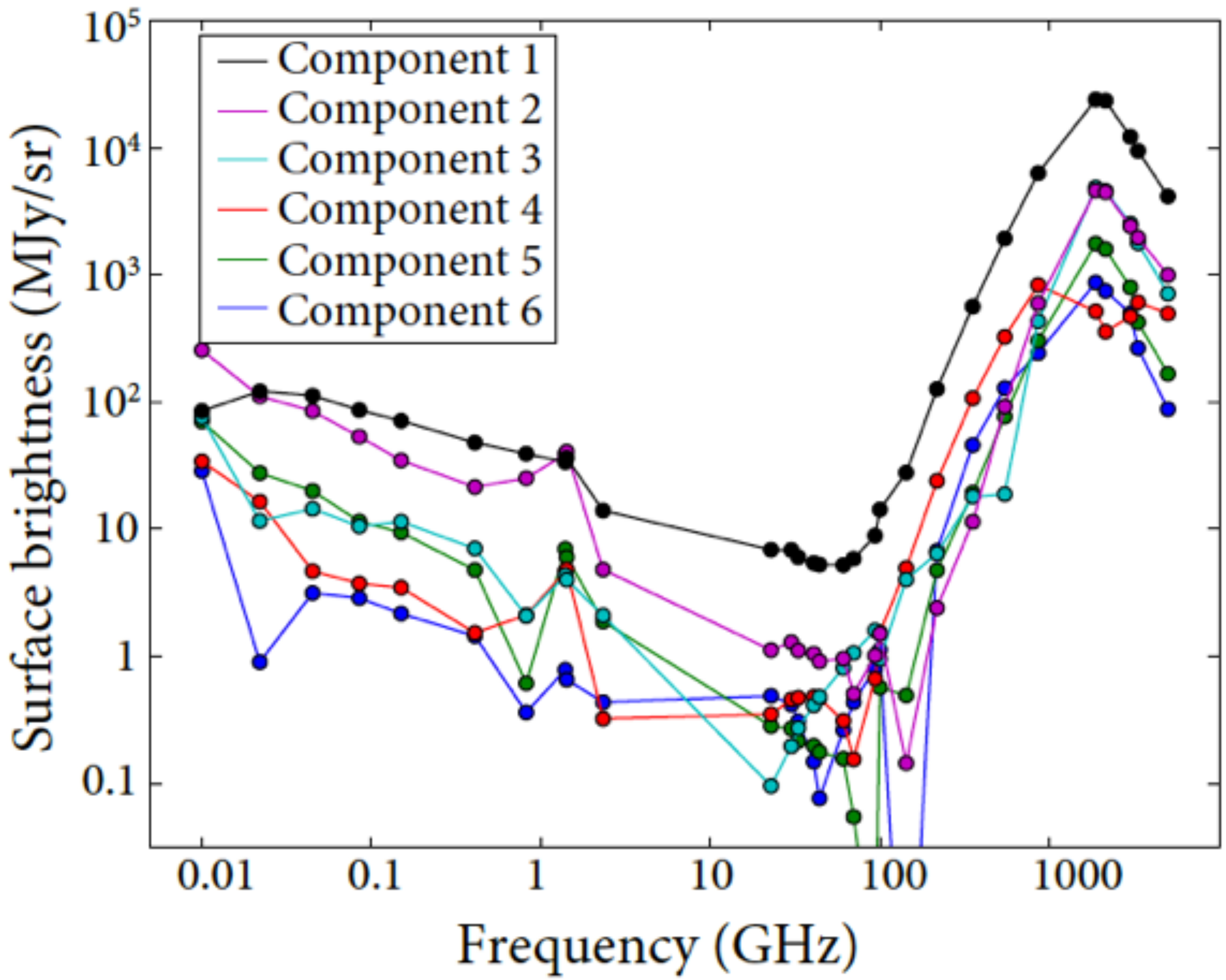
Take an even wider selection of updated maps…



…simultaneously fit for spectral and spatial information across the whole sky, even when there is missing data…



…now using six spectral components…

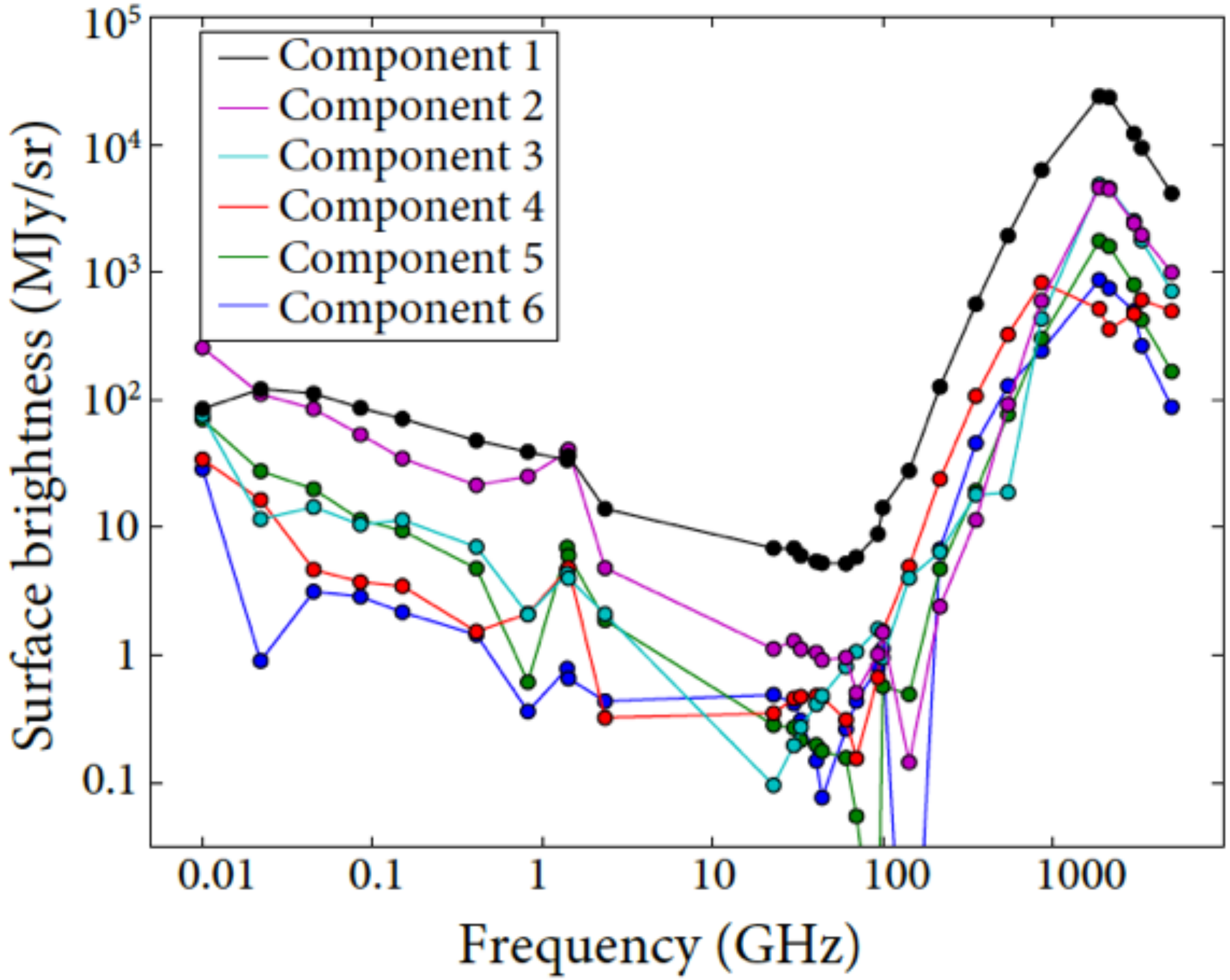


…to derive even higher quality maps.

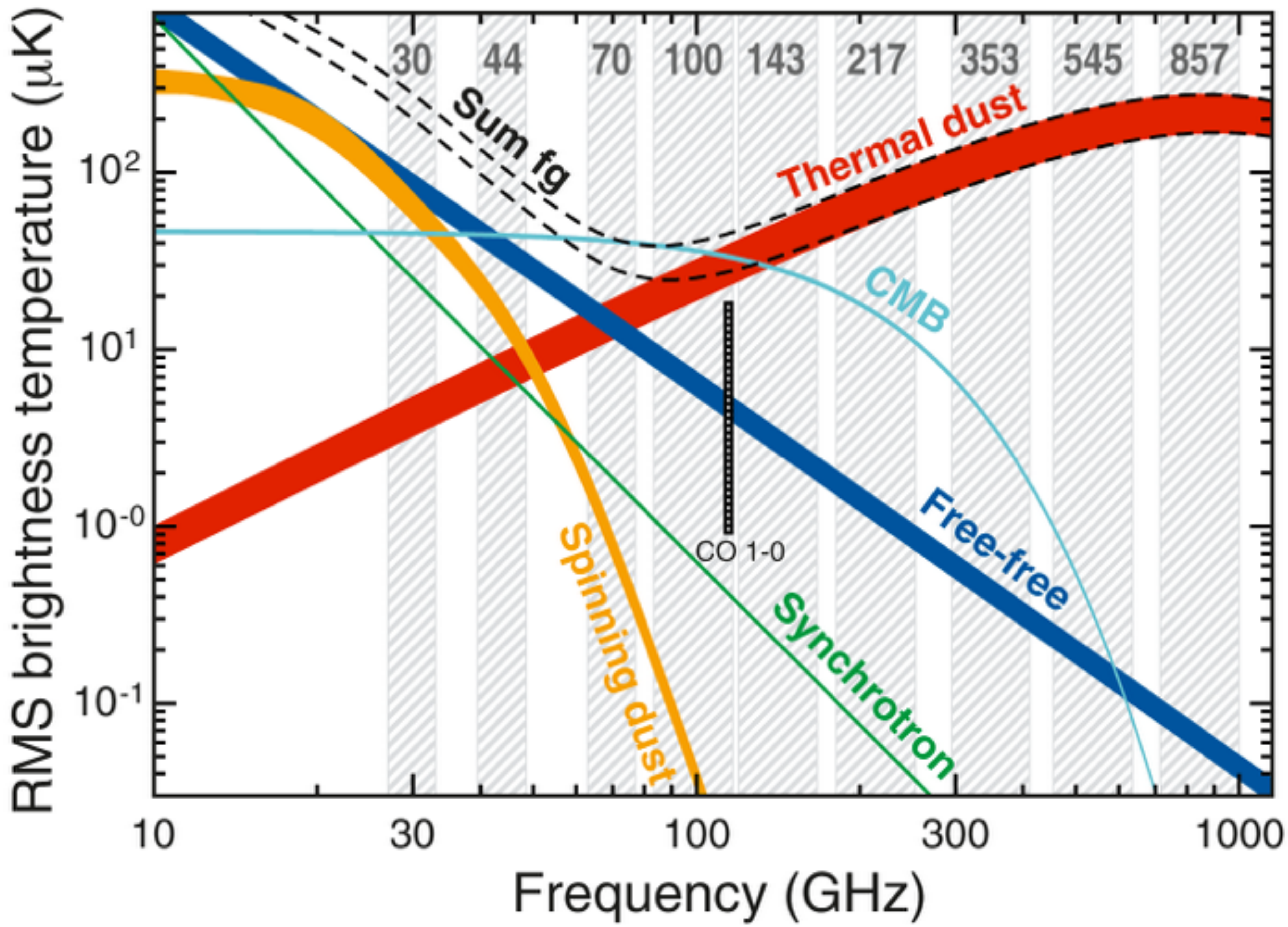
…to derive even higher quality maps.

By design, the eGSM does not explicitly model physical components

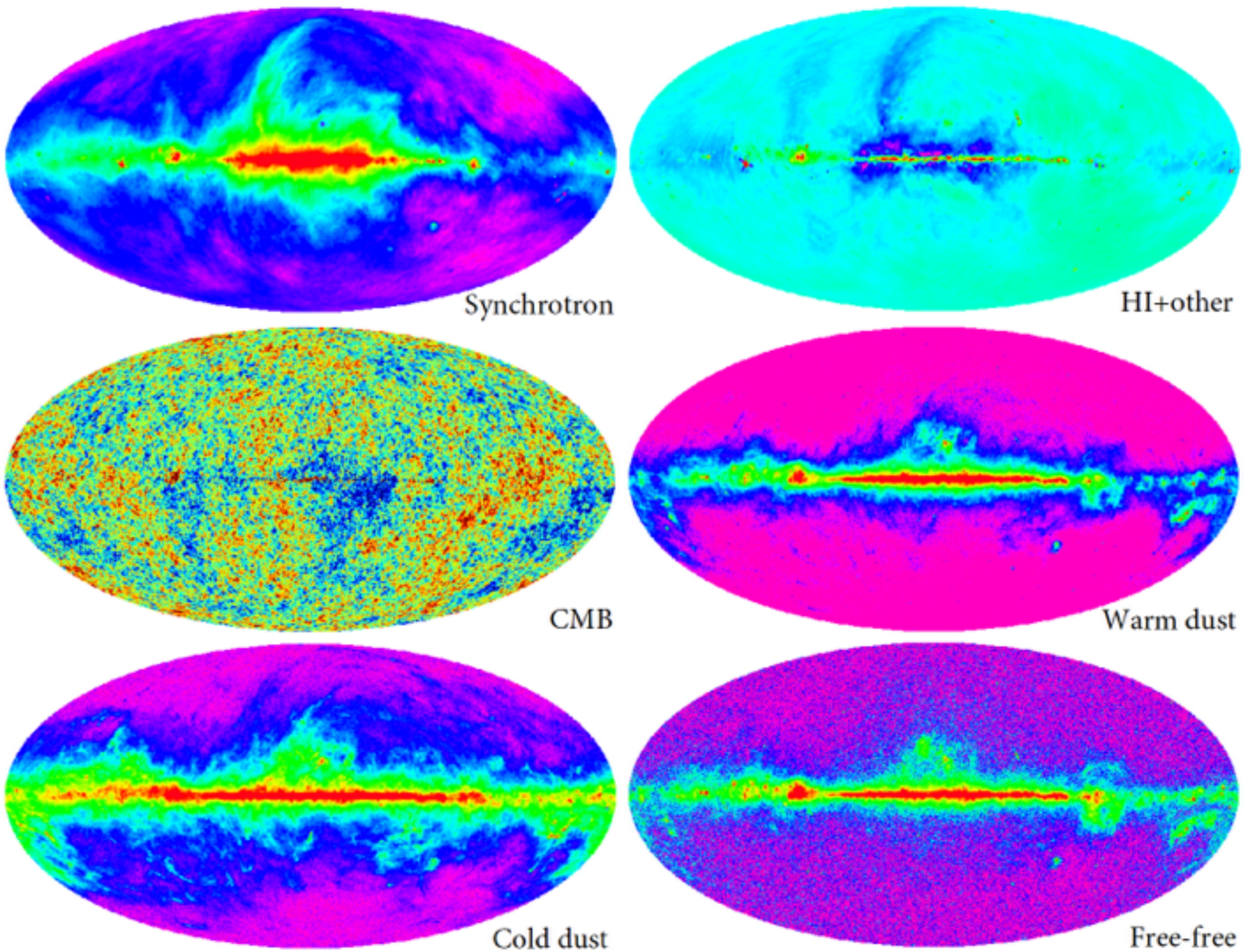
The principal components are not physical foreground components



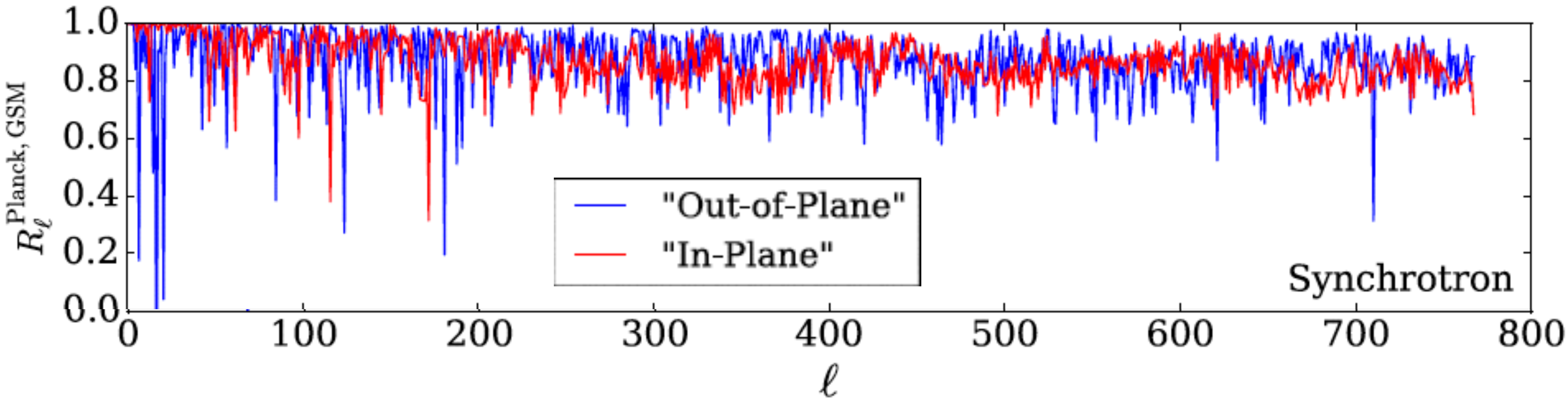
Physical components can be identified by taking linear combinations that dominate at various frequencies



Blindly separated physical component maps from the eGSM

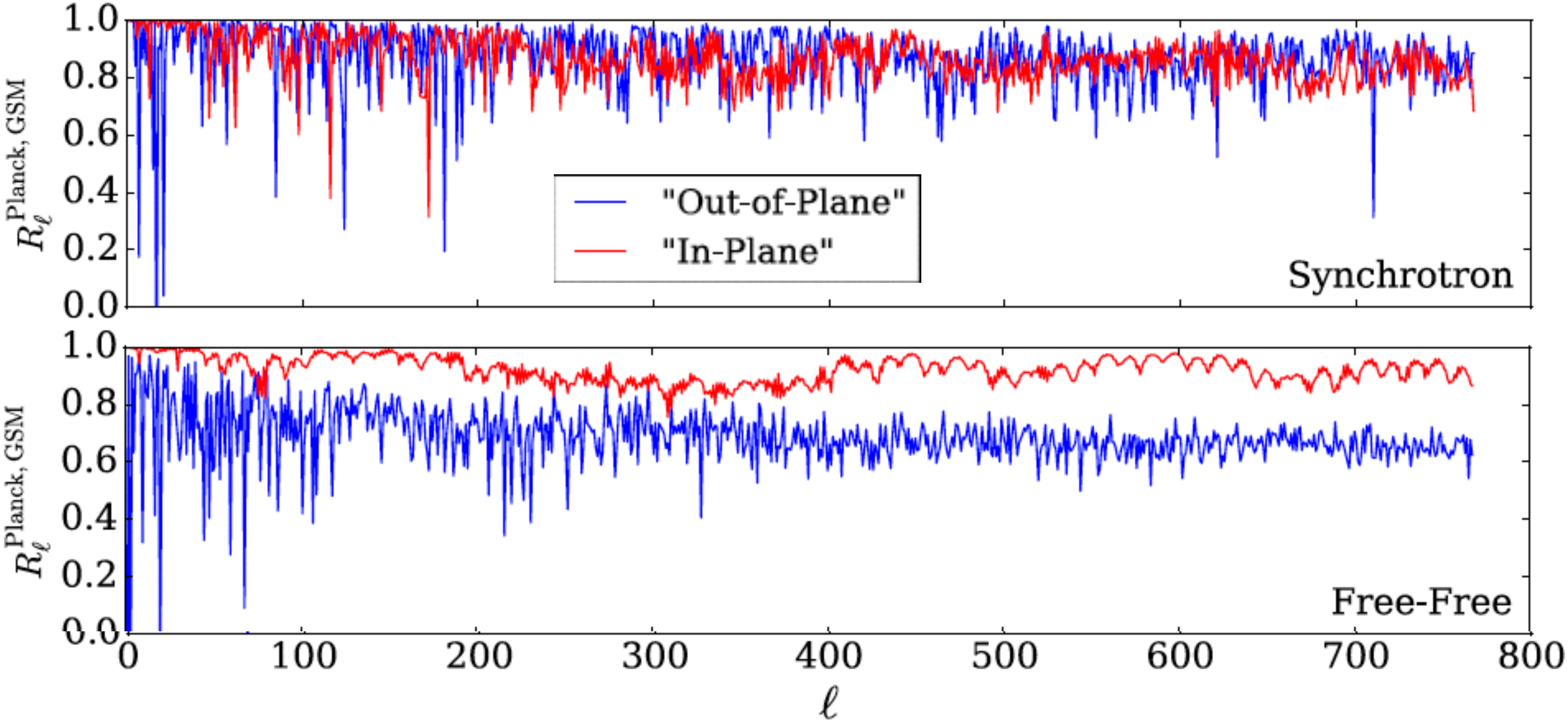


Favorable comparison to Planck data

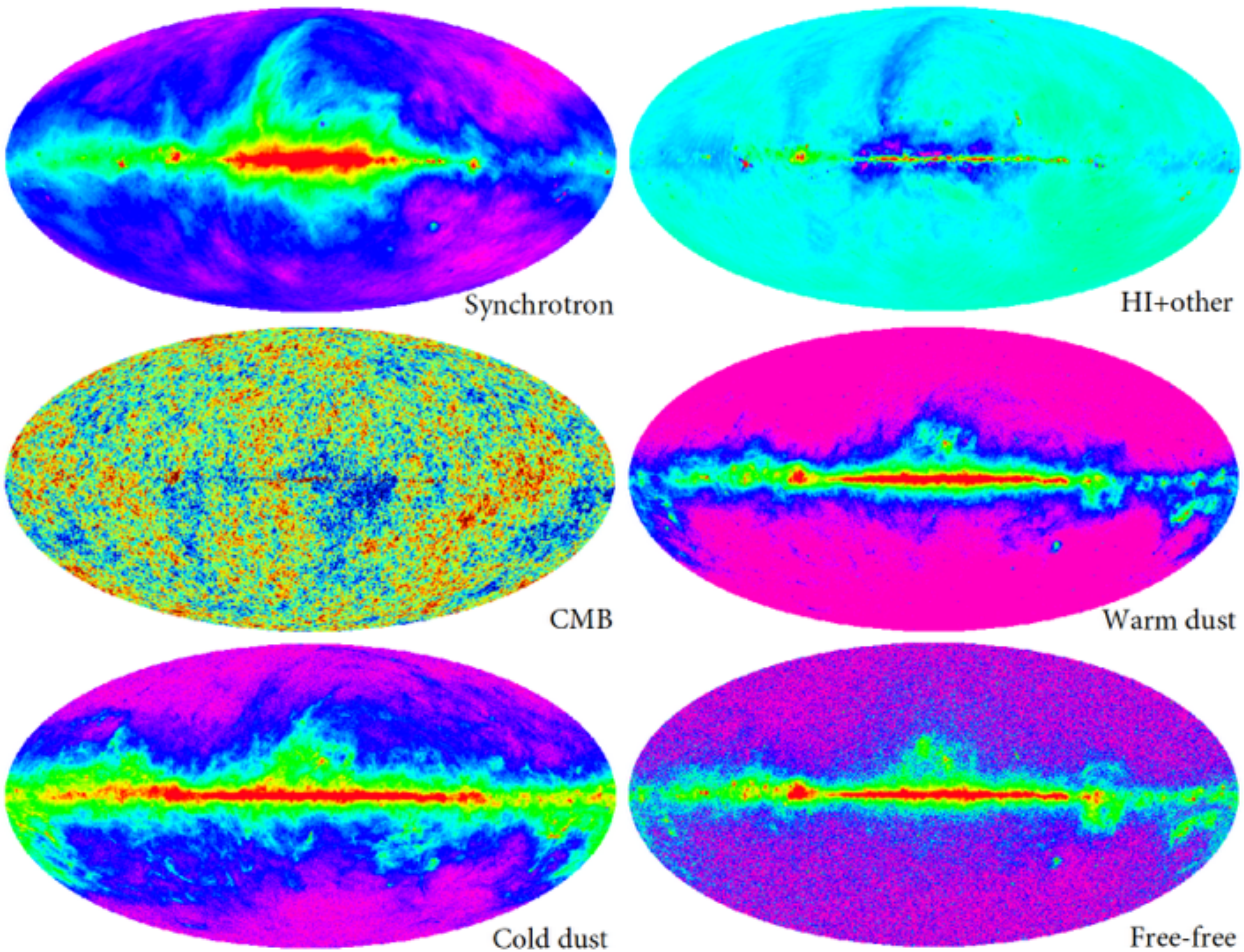


$$R_\ell^{\text{Planck,GSM}} = \frac{C_\ell^{\text{Planck,GSM}}}{\sqrt{C_\ell^{\text{Planck}} C_\ell^{\text{GSM}}}}$$

Favorable comparison to Planck data



Blindly separated physical component maps from the eGSM



Global Sky Model v3

(Kim, **AL**… et al. 2017, in prep.)

Why three components?
Why six components?

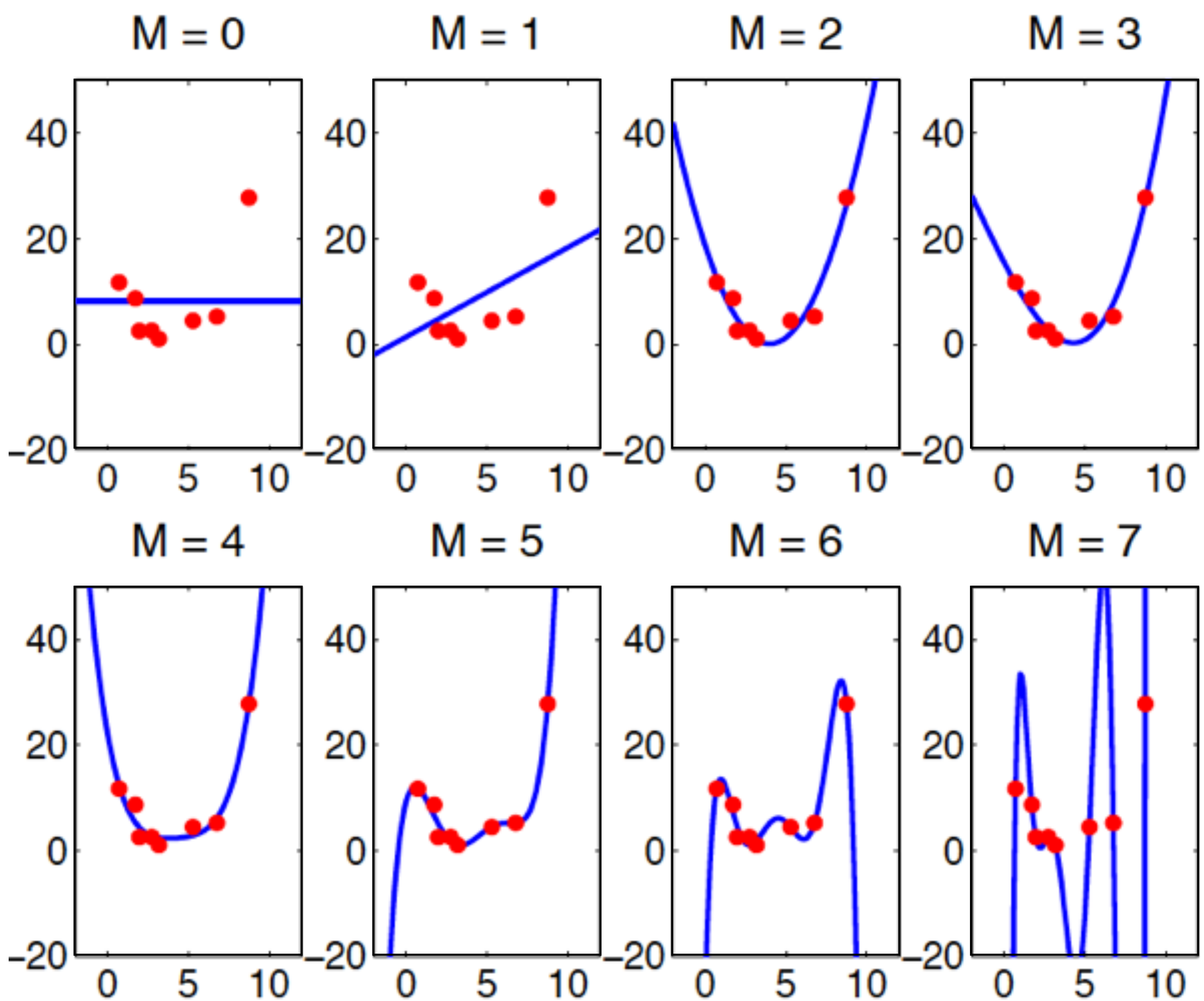
Why three components?
Why six components?

Too few components: inadequate fits to data
Too many components: overfitting of data

Computing the Bayesian Evidence provides a way to determine the optimal number of principal components to fit

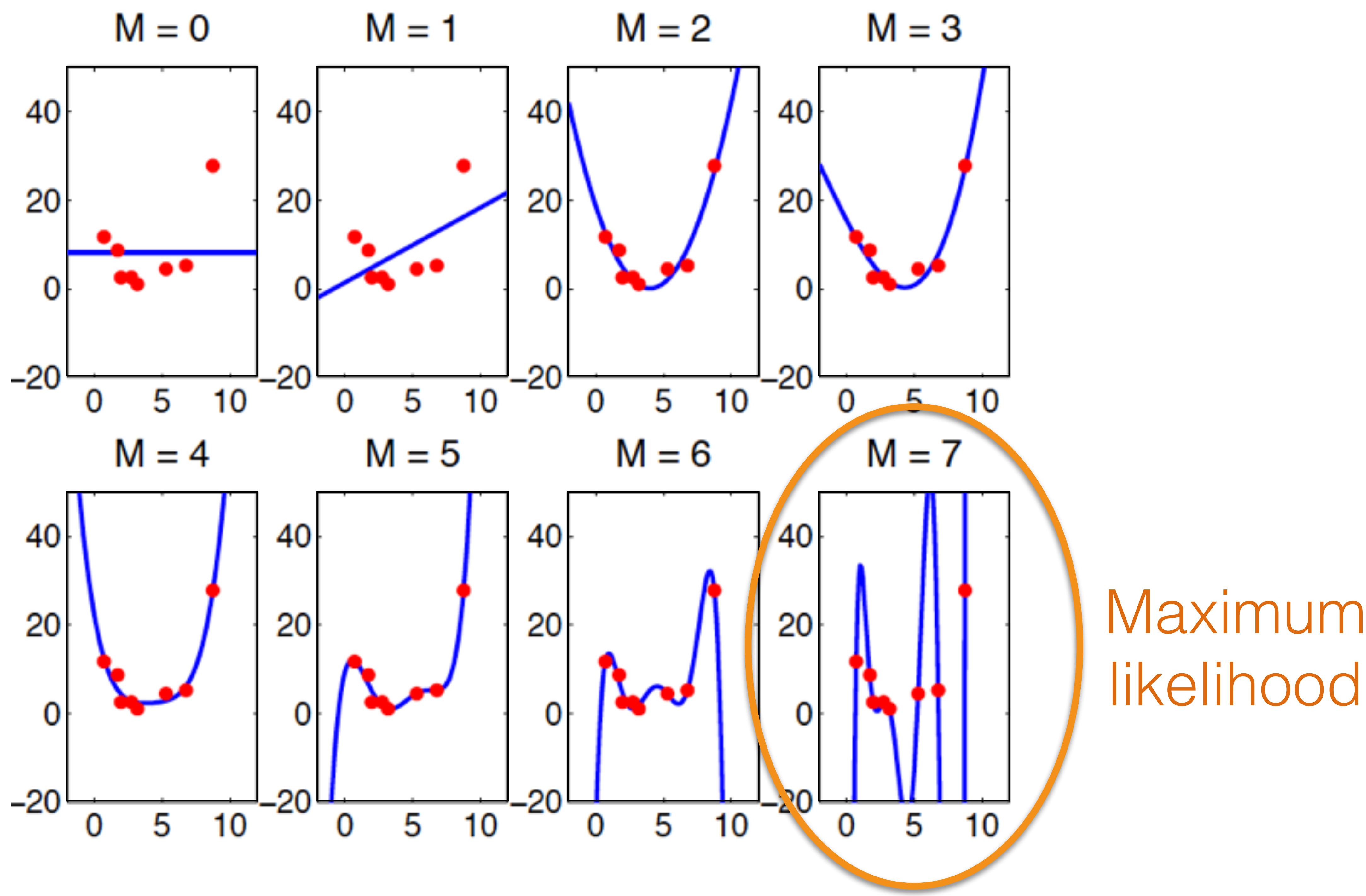
Computing the Bayesian Evidence provides a way to determine the optimal number of principal components to fit

Image credit:
Zoubin Ghahramani



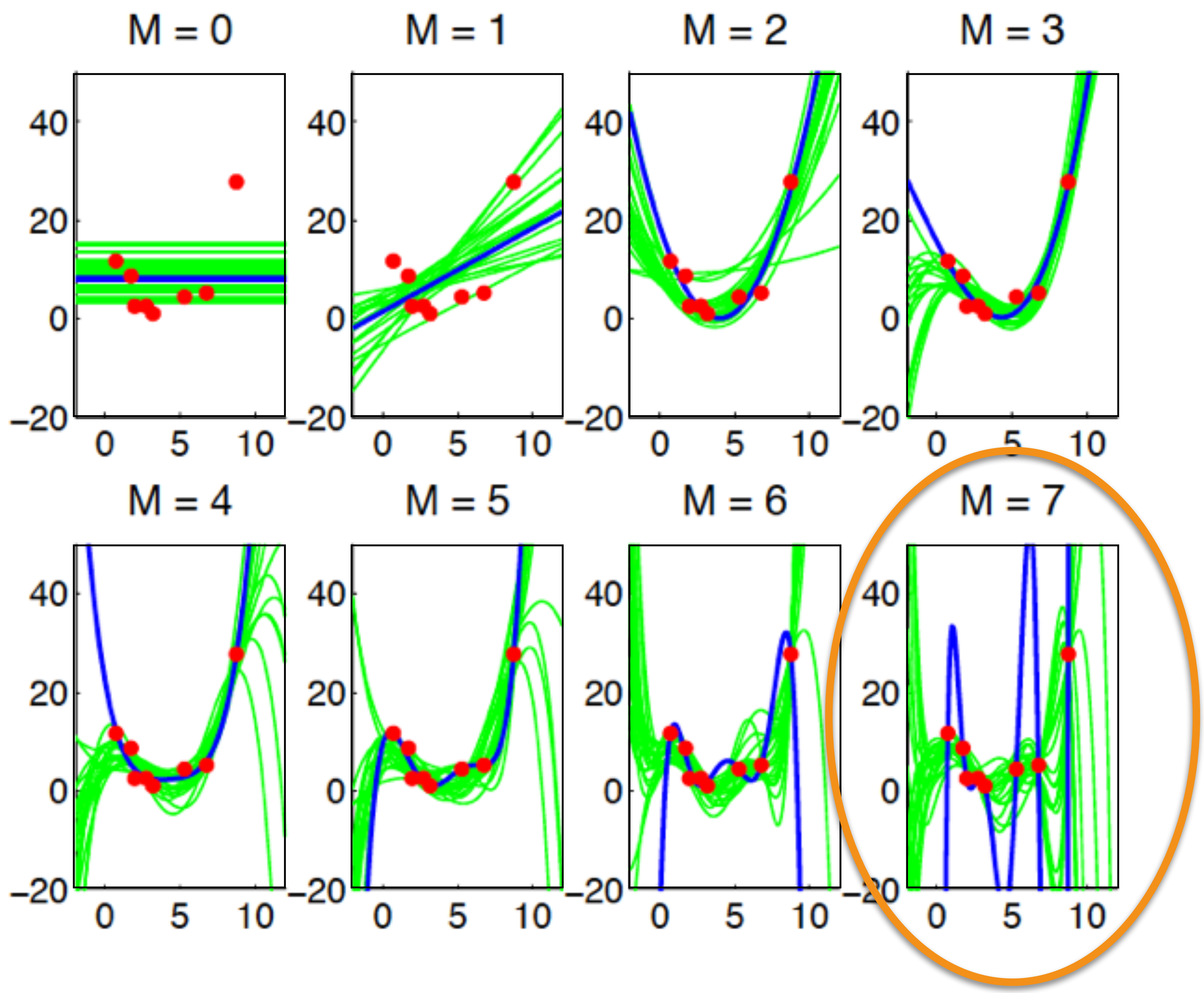
Computing the Bayesian Evidence provides a way to determine the optimal number of principal components to fit

Image credit:
Zoubin Ghahramani



Computing the Bayesian Evidence provides a way to determine the optimal number of principal components to fit

Image credit:
Zoubin Ghahramani



Maximum likelihood

Computing the Bayesian Evidence provides a way to determine the optimal number of principal components to fit

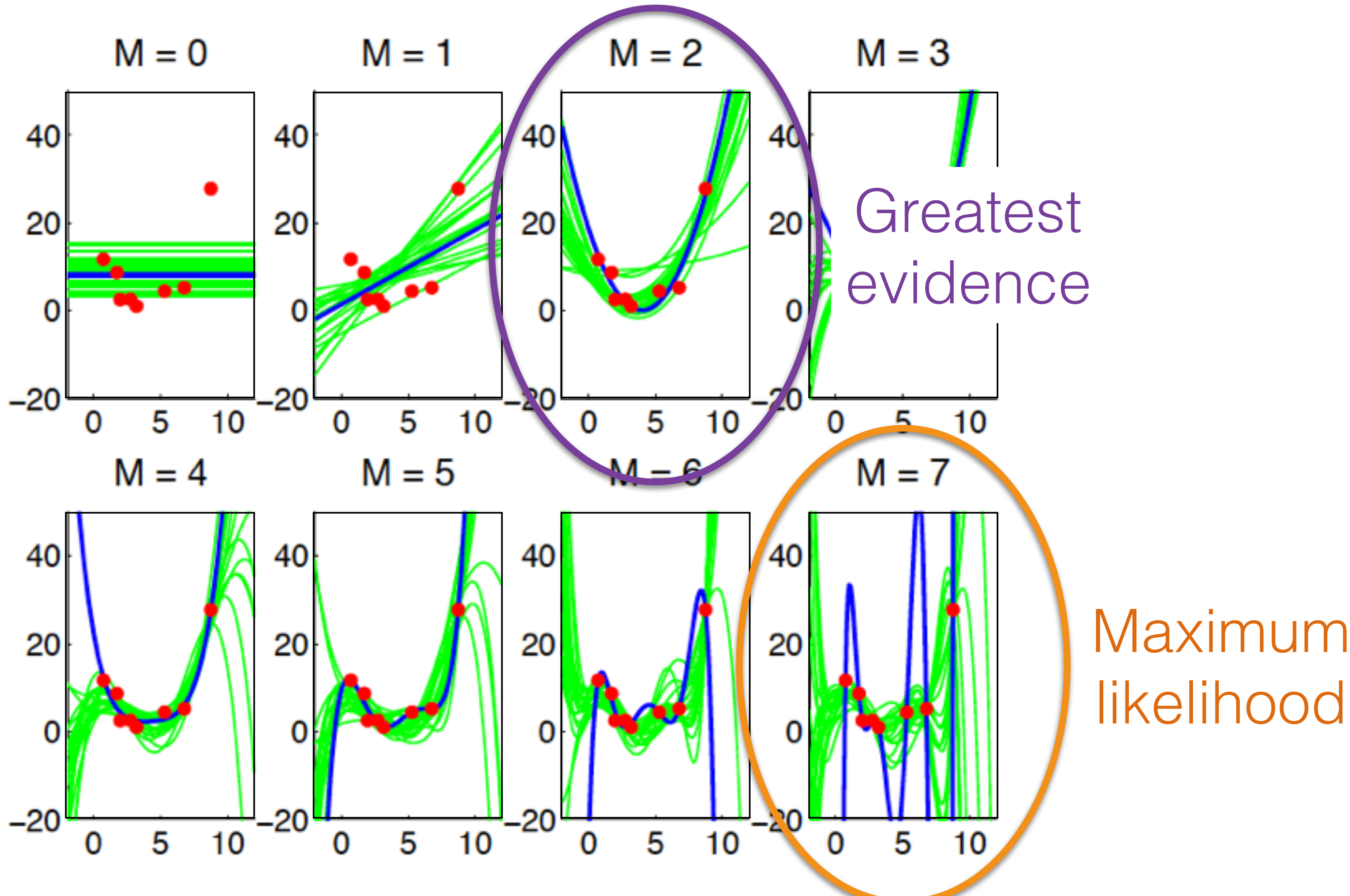
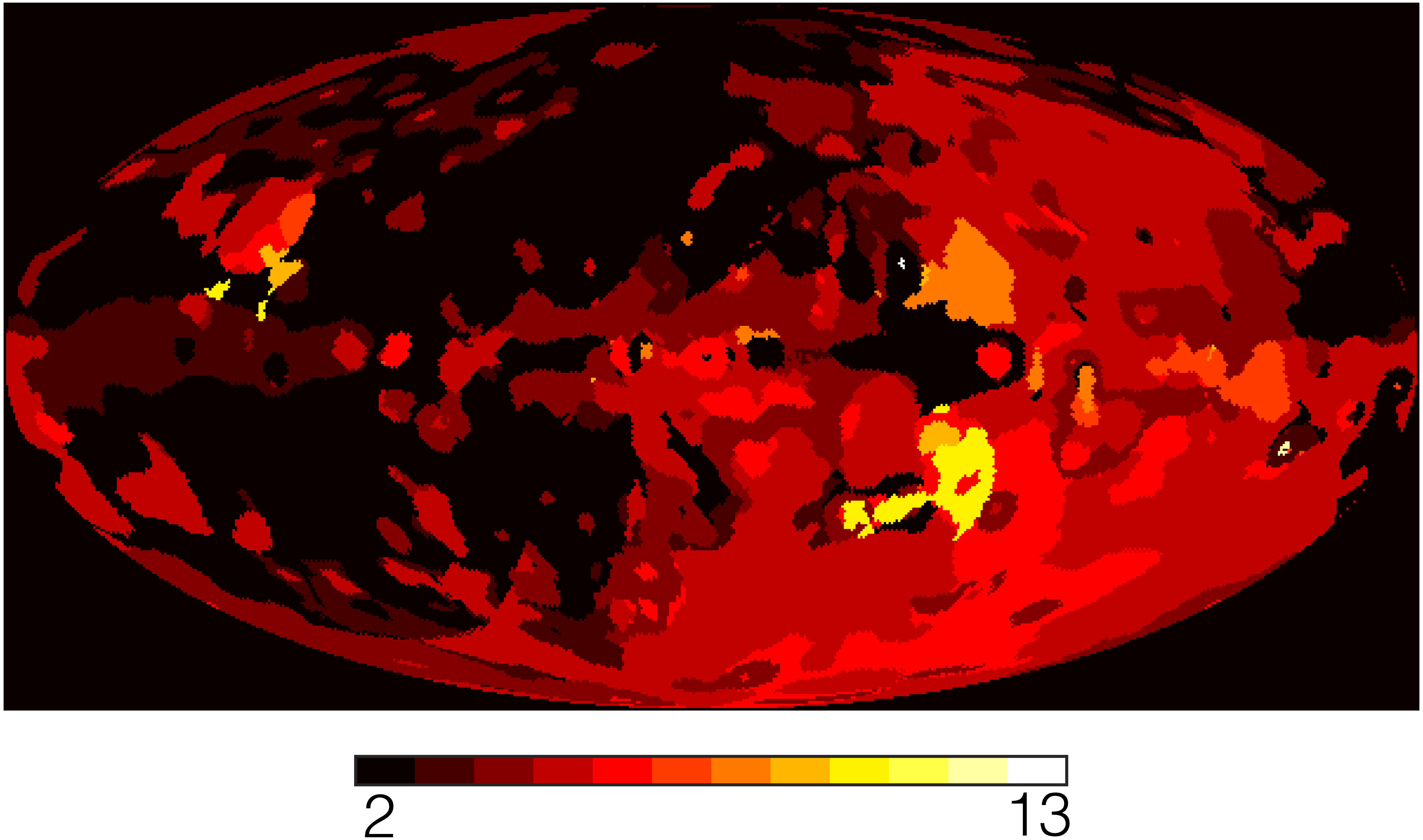


Image credit: Zoubin Ghahramani

Optimal number of principal components



Lots more coming soon to a Github repo near you!

Already in progress

- Position-dependent number of components.
- Error bars in output maps.
- Framework for incorporating global signal measurements.

Commencing 2017

- Polarization maps (Switzer).
- Inclusion of new global signal + map data.