planck

The Planck Sky Model (PSM)

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On behalf of the Planck Collaboration

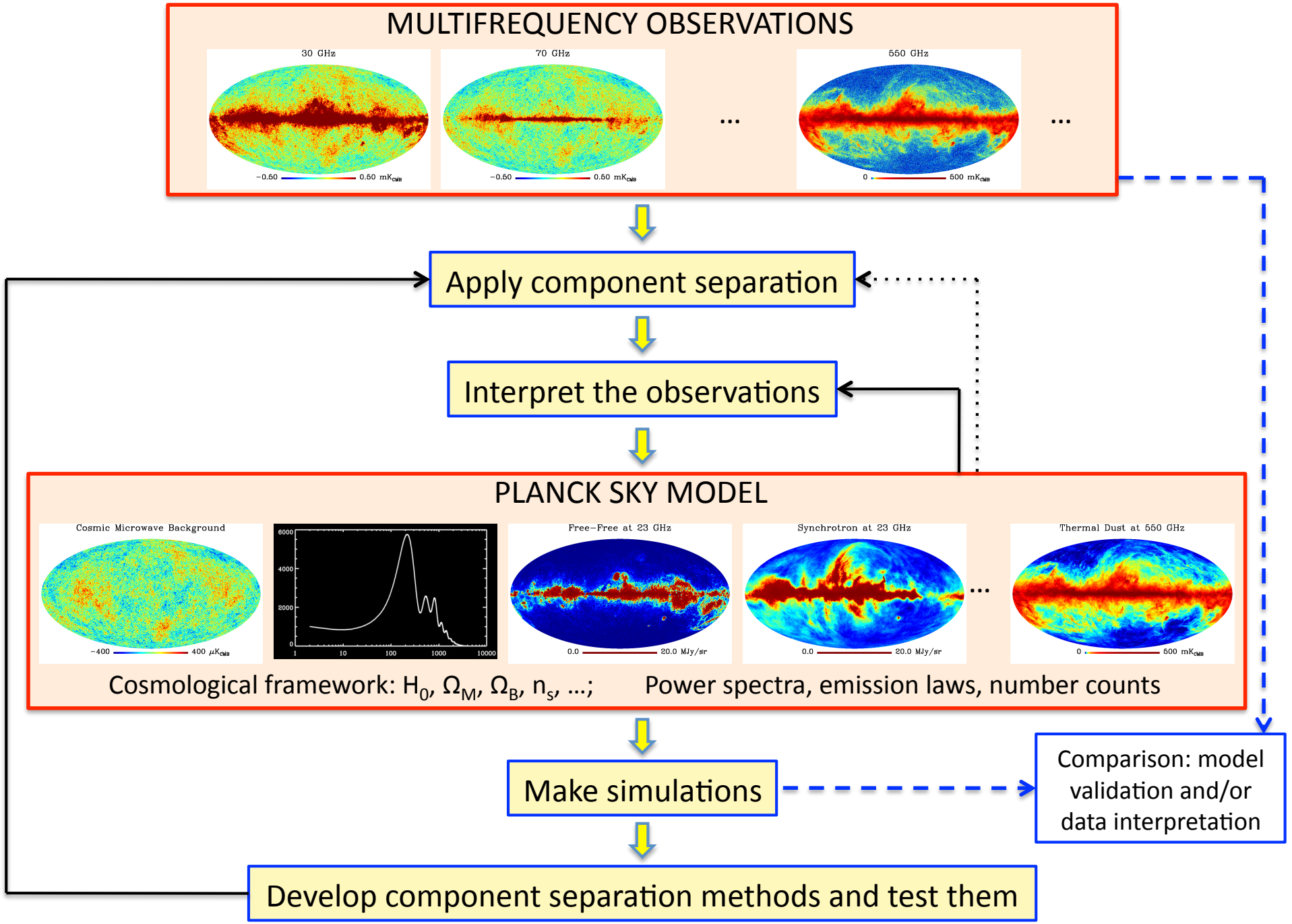
- General philosophy and objectives
- Implementation and status
- Summary

A PSM wish list

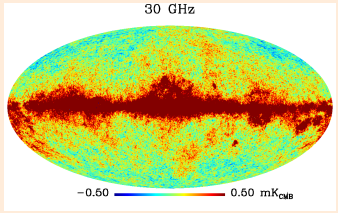
- A multi-component model

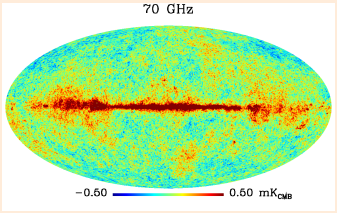
- Perfect representation of the real sky ?
  - For each component, provide IQU(v, p) at any frequency v and for any point p on the sky
  - Provide values parameters of interest (e.g. cosmological parameters, statistical properties, etc.)
  - Be compatible with all observations

- A tool for simulating sky emission and its observations
  - Statistically representative
  - Parametric


MULTIFREQUENCY OBSERVATIONS
30 GHz
70 GHz
550 GHz
Apply component separation
Interpret the observations
PLANCK SKY MODEL
Cosmic Microwave Background
Free−Free at 23 GHz
Synchrotron at 23 GHz
Thermal Dust at 550 GHz
Cosmological framework: H0, ΩM, ΩB, ns, …;
Power spectra, emission laws, number counts
Make simulations
Comparison: model validation and/or data interpretation
Develop component separation methods and test them

MULTIFREQUENCY OBSERVATIONS





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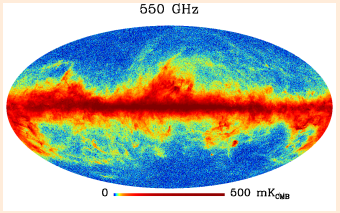

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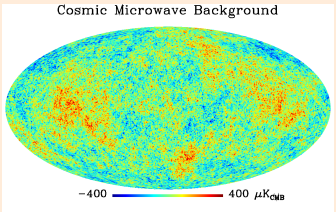
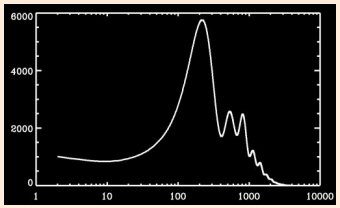
Apply component separation

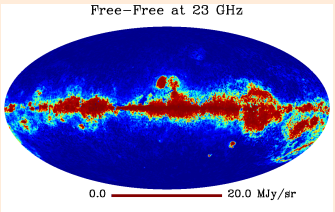
PSM ACTIVITY

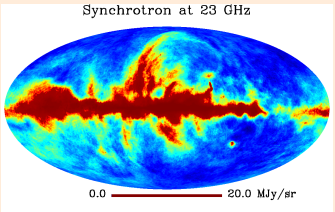
Interpret the observations

PLANCK SKY MODEL









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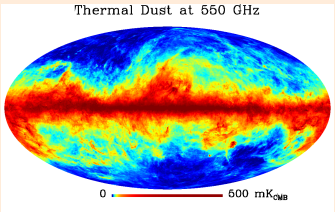

Cosmological framework: H_0, Ω_M, Ω_B, n_s, …; Power spectra, emission laws, number counts

Make simulations

Comparison: model validation and/or data interpretation

Develop component separation methods and test them

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Components

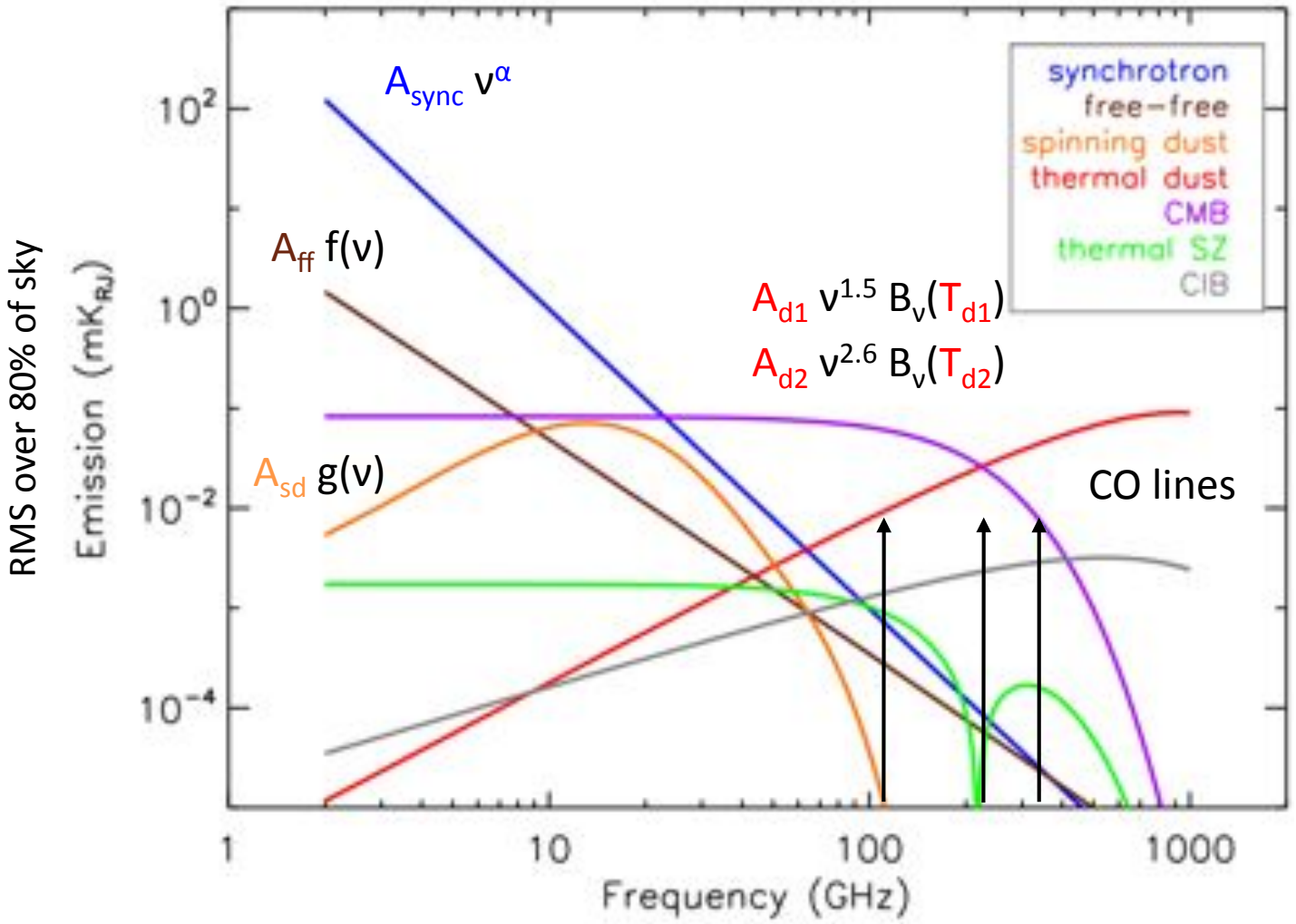
- Check PSM paper for details
  - *Delabrouille et al., A&A, in press, arXiv:1207.3675*

- Specific changes for FFP6:

  - Template emission for galactic dust at 100 microns obtained by scaling a de-sourced, filtered version of the Planck 857 GHz channel (from a previous internal release)

  - CIB emission

Components in FFP6 simulations



SZ effect with 1st order relativistic corrections
1.3 million clusters
$M > 5\times10^{13}\ M_\odot$

Kinetic SZ included

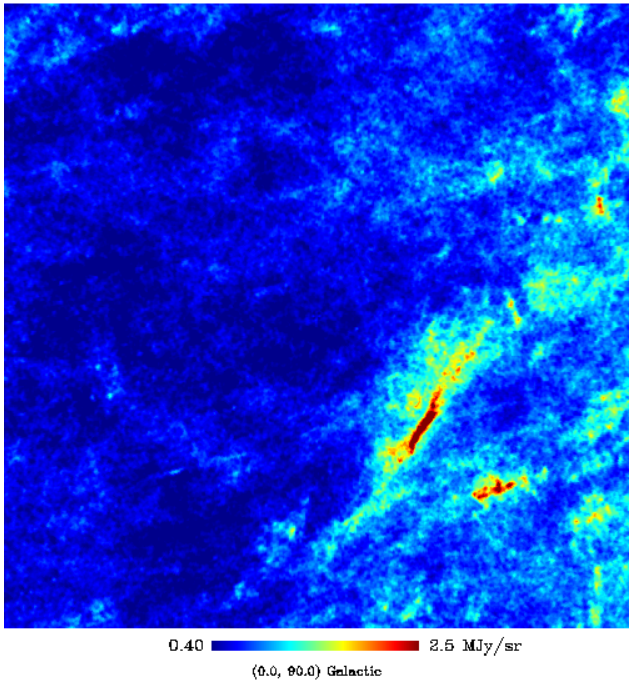
Non-Gaussian CMB
$F_{NL} = 20.4075$
$l_{max} = 4500$
lensing included

CIB from distribution of galaxies in 10 shells of density contrast

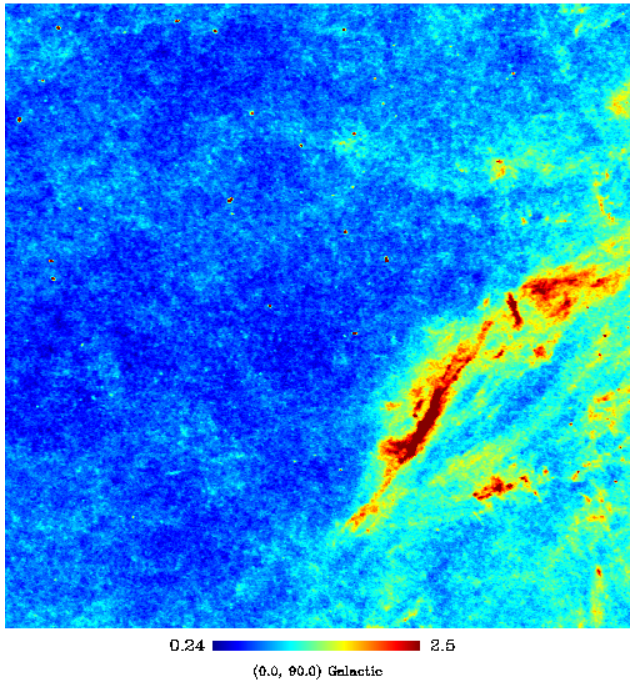
Radio and IR sources

Thermal dust at 857 GHz

FROM SFD model

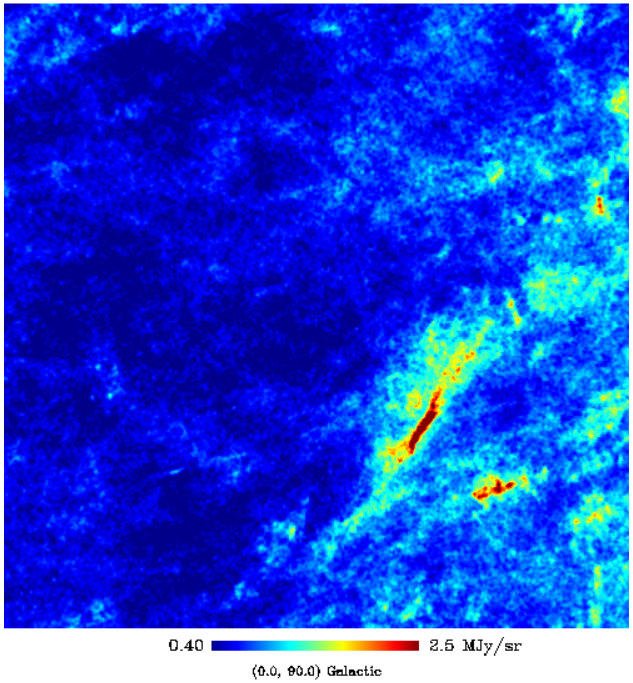


Planck map

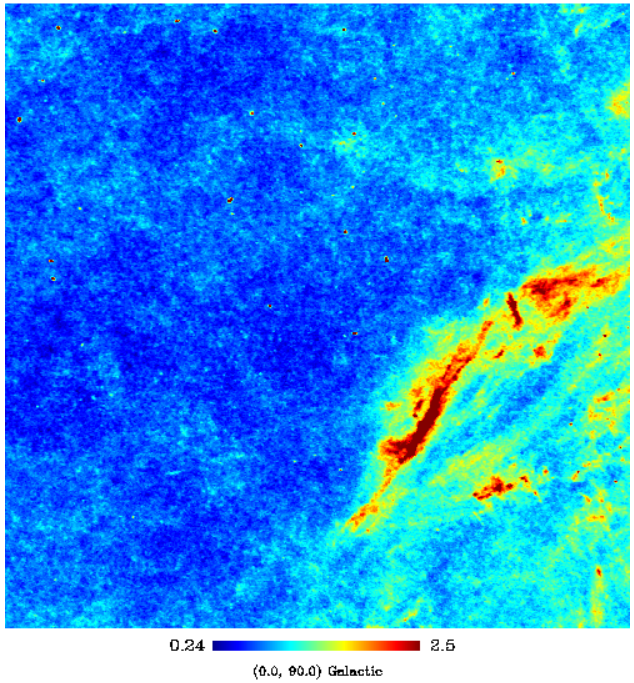


Thermal dust at 857 GHz

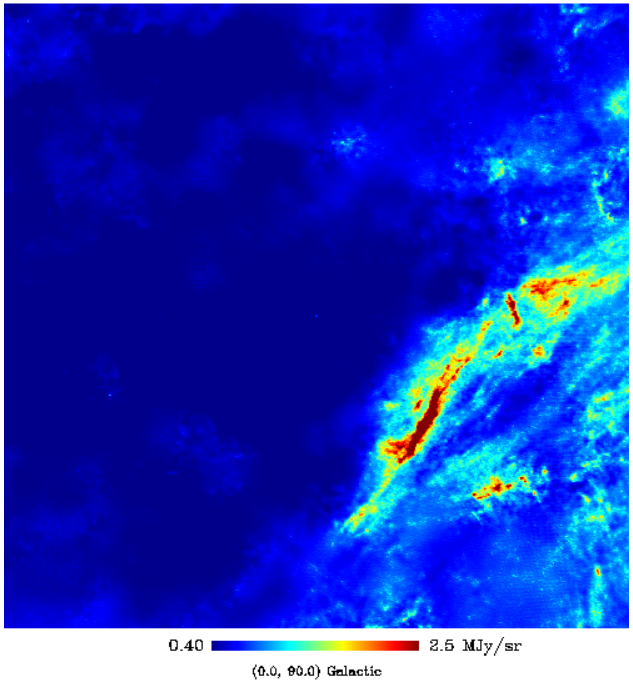
FROM SFD model



Planck map

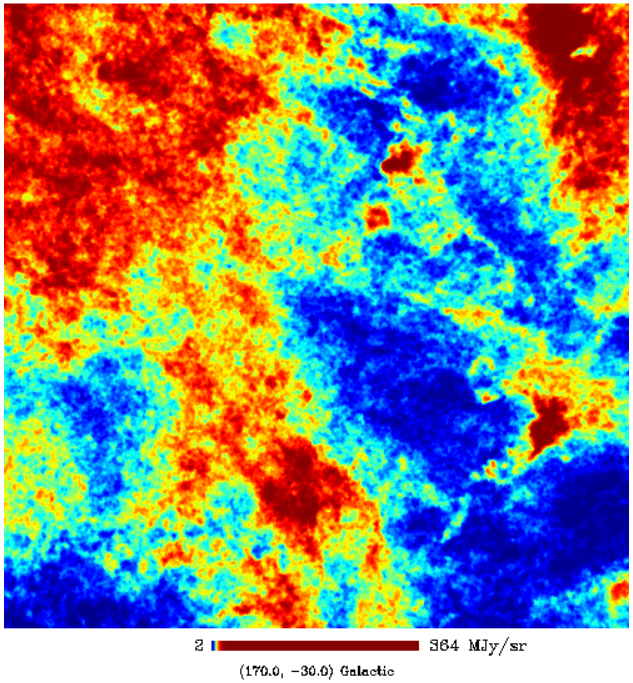


FFP6

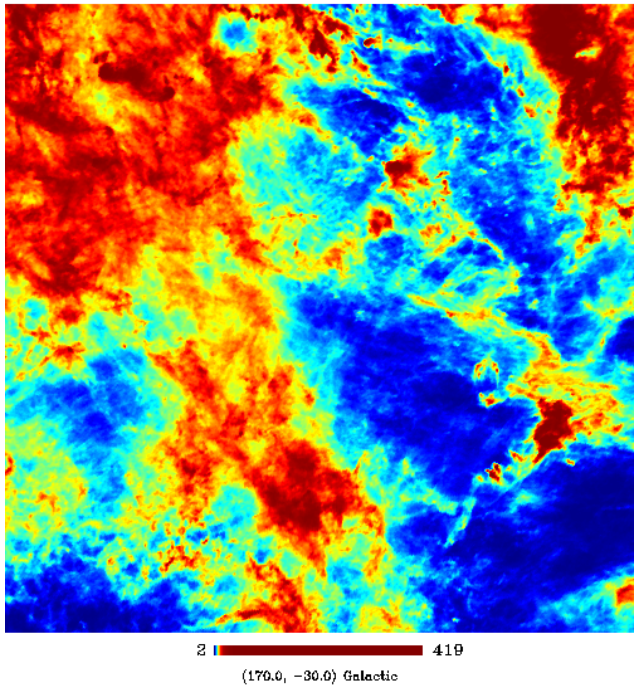


Thermal dust at 857 GHz

FROM SFD model



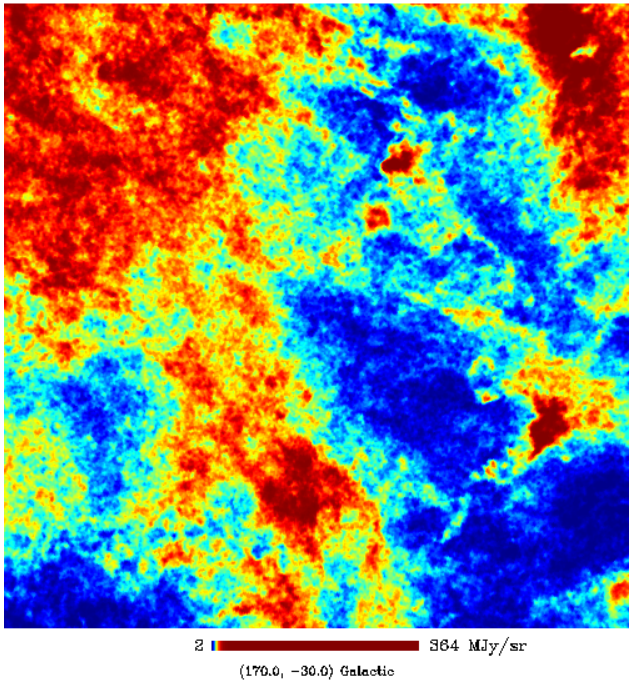
Planck map



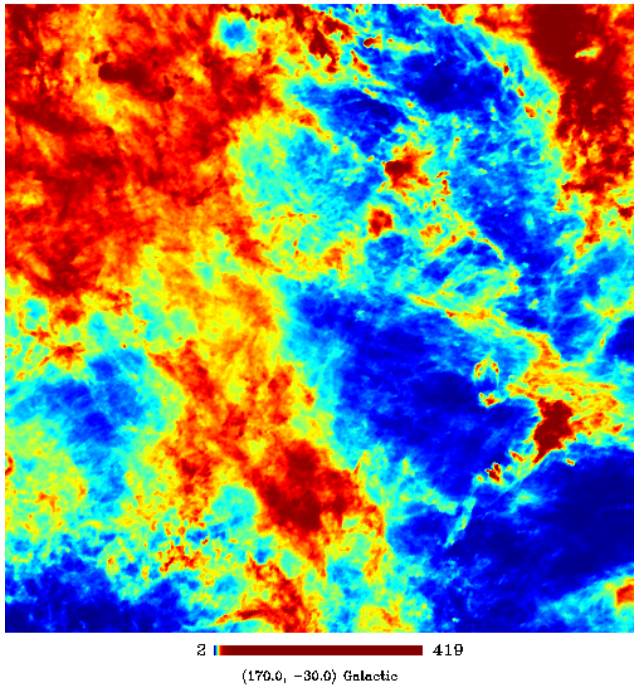
Gaussian small scale fluctuations added to 9’ SFD map…

Thermal dust at 857 GHz

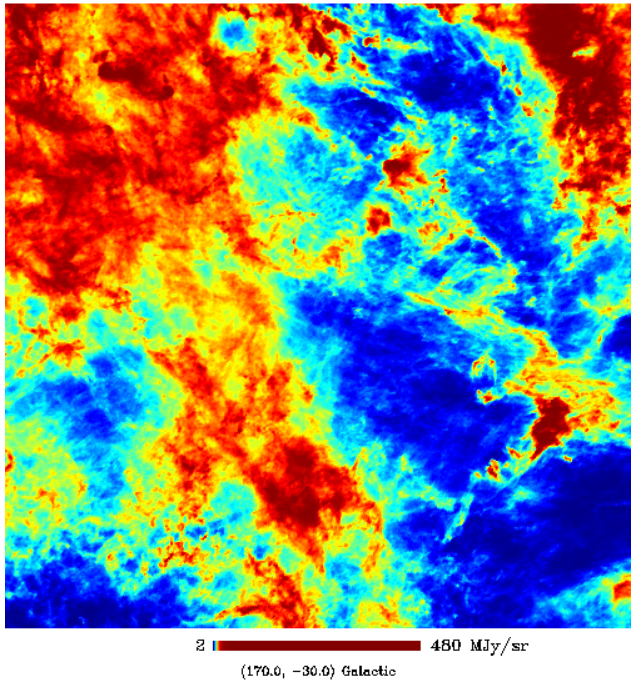
FROM SFD model



Planck map



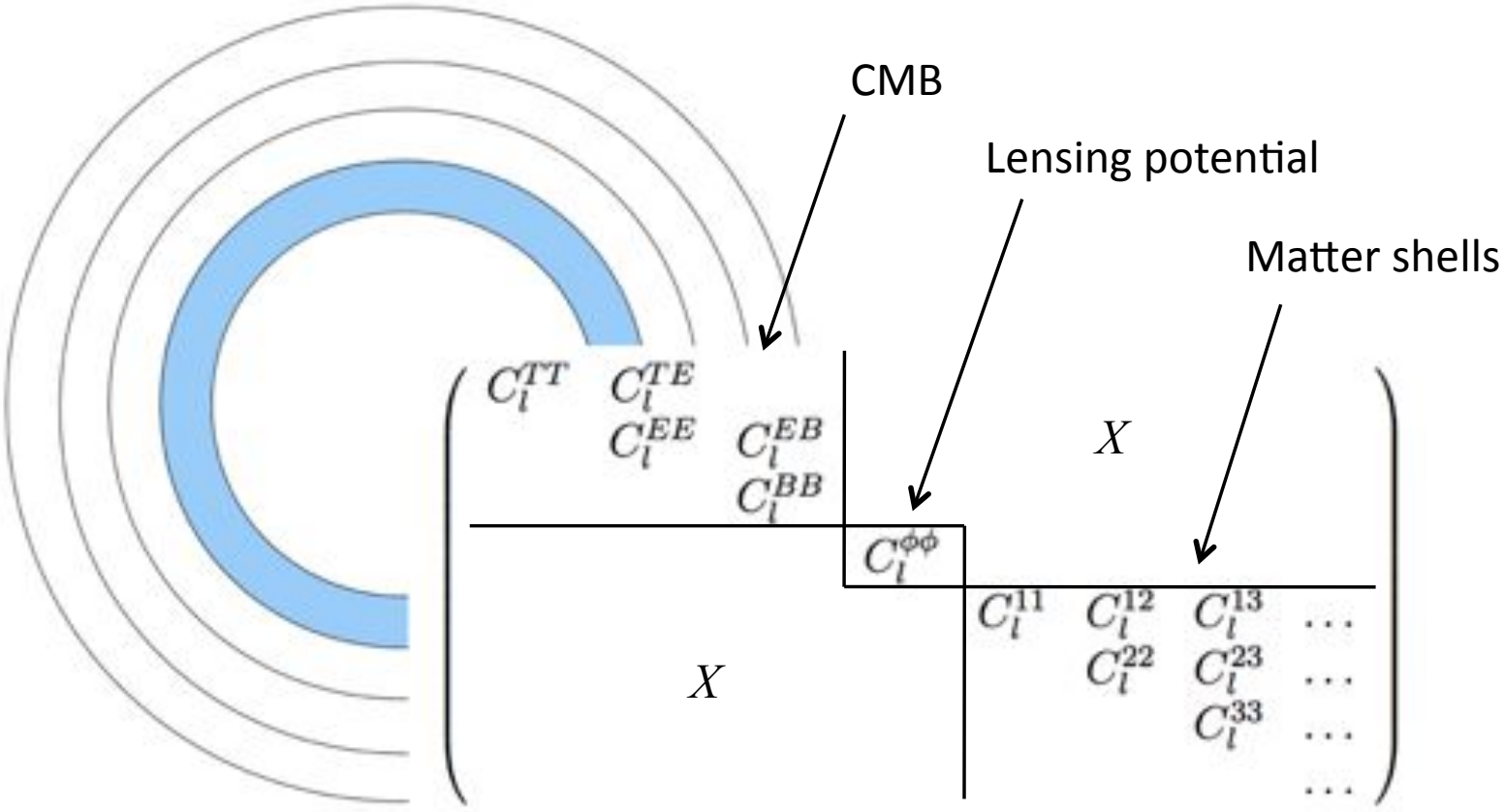
FFP6



CIB: Cosmological framework

- Standard cosmology (h, Ω_m, Ω_b, Λ, A_s, n_s, τ, r, …)
- CAMB and CLASS interfaced to compute CMB C_l and matter $P_k(z)$
- The cosmological model is used consistently for modeling CMB, cluster counts, velocity flows, shells of density contrast used for the CIB)

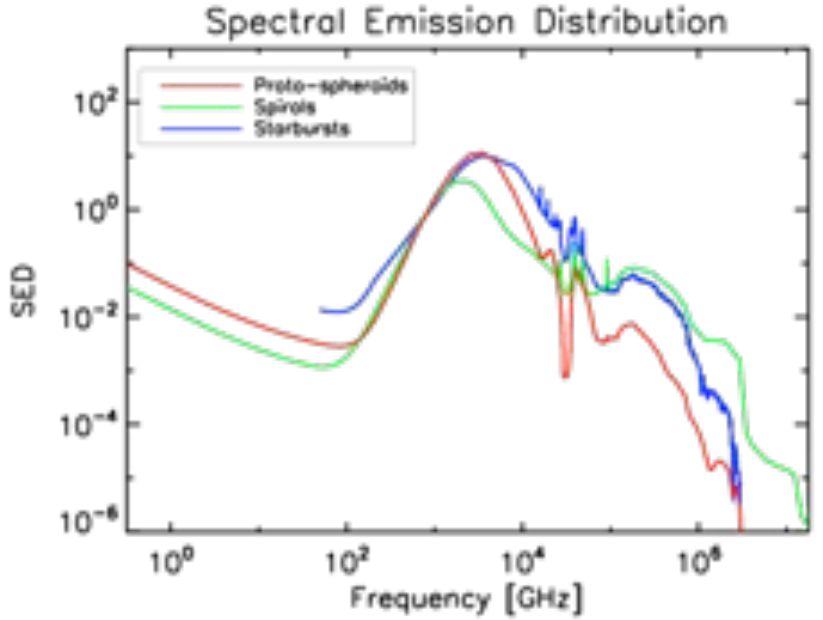
Shells of density contrast

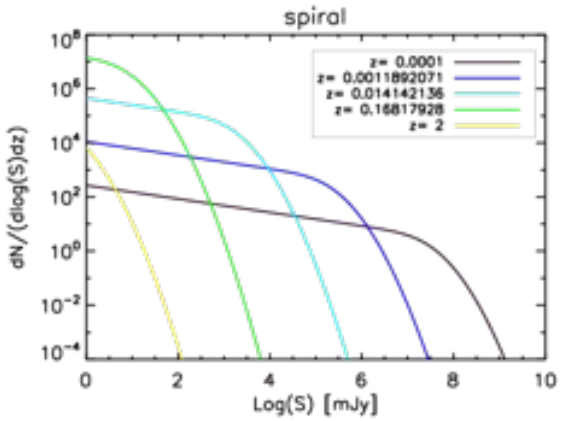


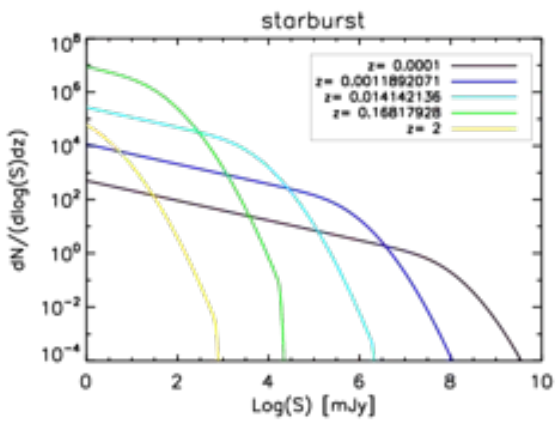
CIB galaxies

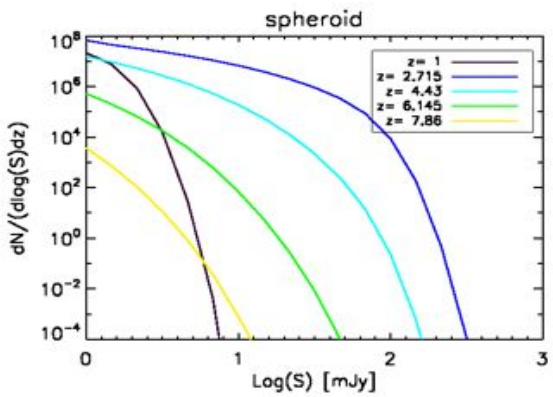
Shells are populated with galaxies on the basis of number counts.

Probability distribution according to local $\delta\rho/\rho$ (with a prescription for bias)

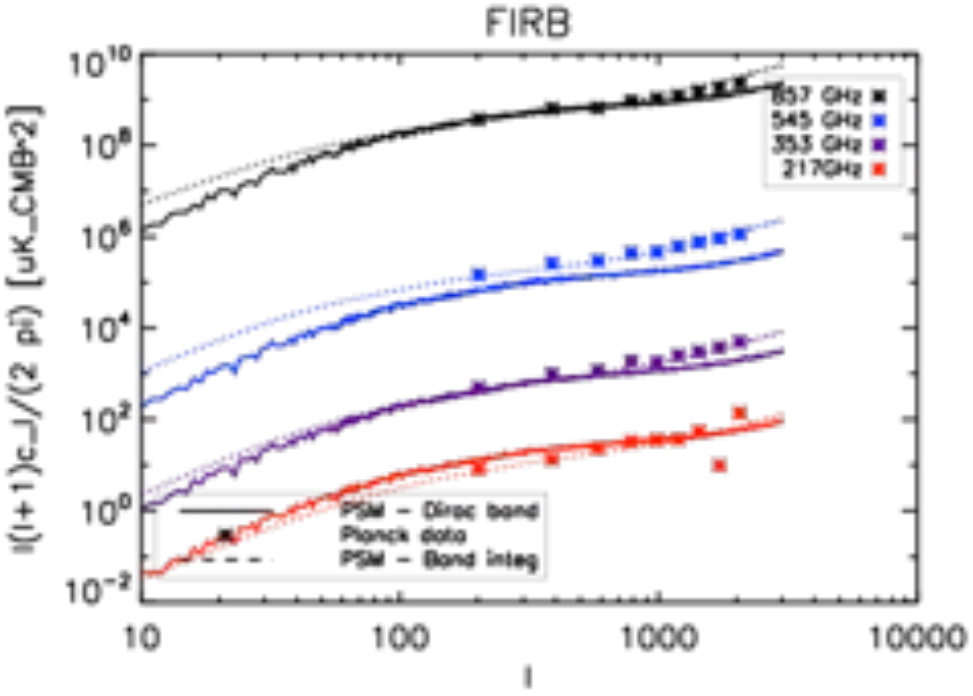








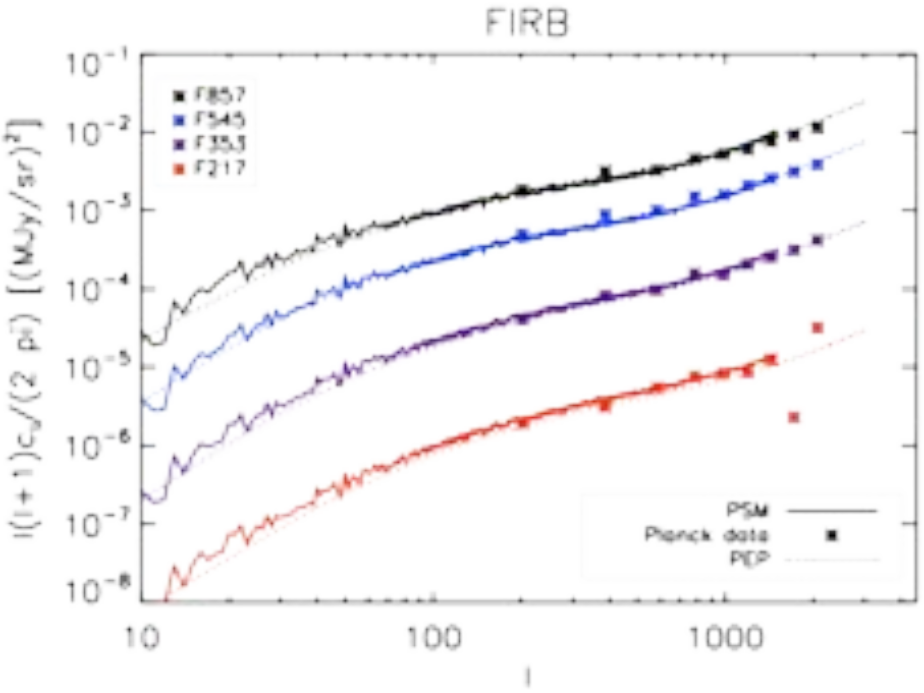
CIB maps

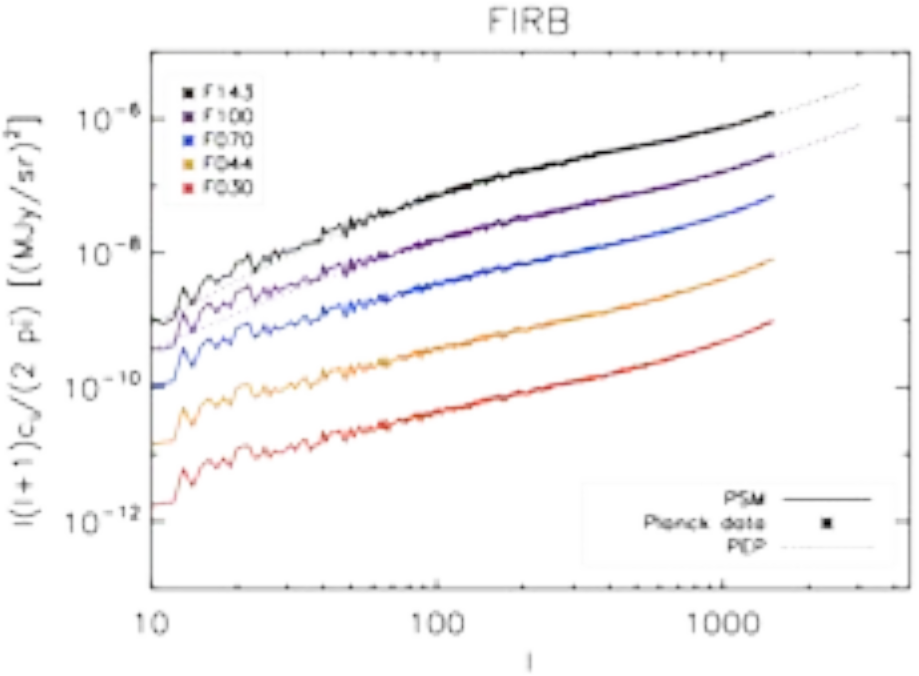


Power spectra from this CIB model are close to measured Planck CIB spectra, but not exactly consistent…

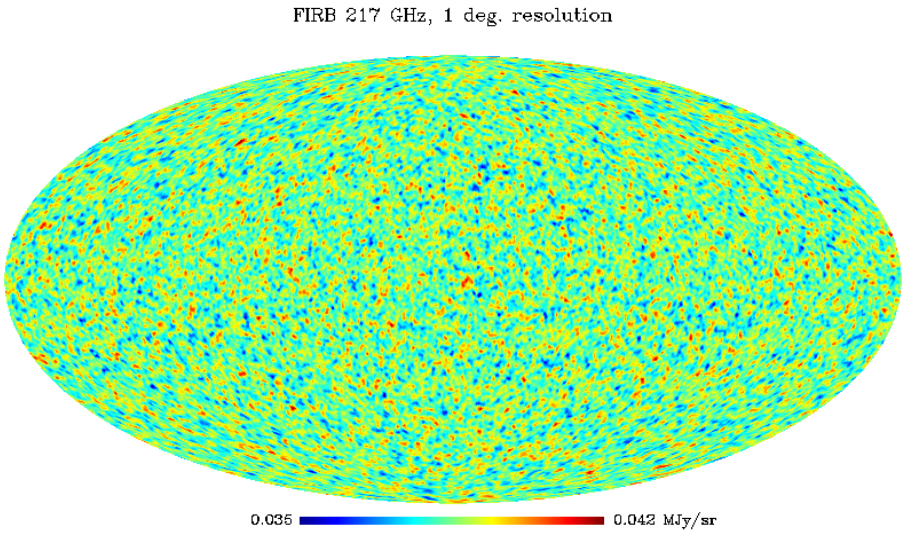
Spectra re-adjusted to match Planck PEP C_l measurements
+
decorrelation added artificially between lowest and highest frequencies

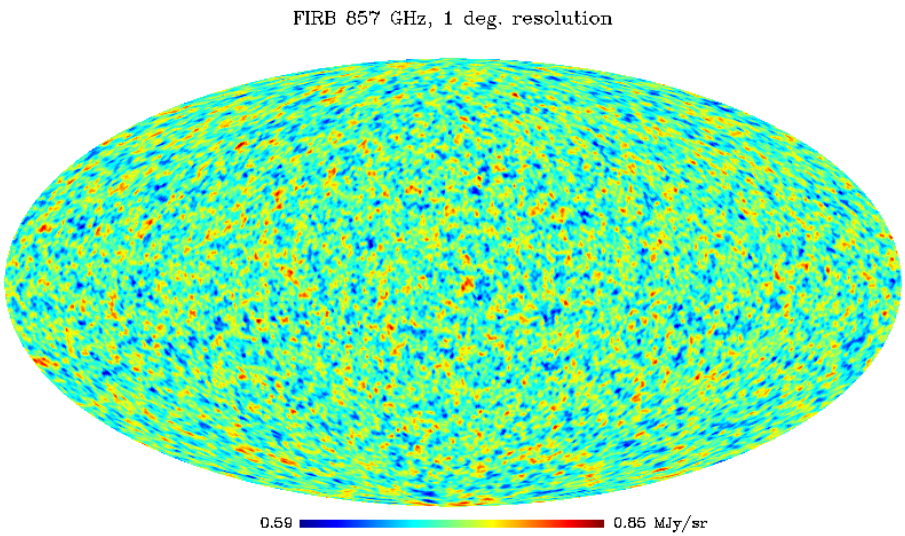
CIB spectra


FIRB
F857
F545
F353
F217
PSM
Planck data
PEP
10
100
1000
l

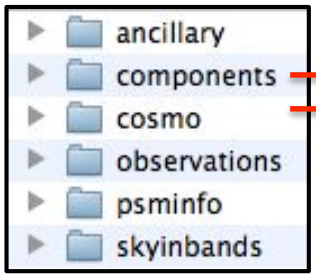

FIRB
F143
F100
F070
F044
F030
PSM
Planck data
PEP
10
100
1000
l

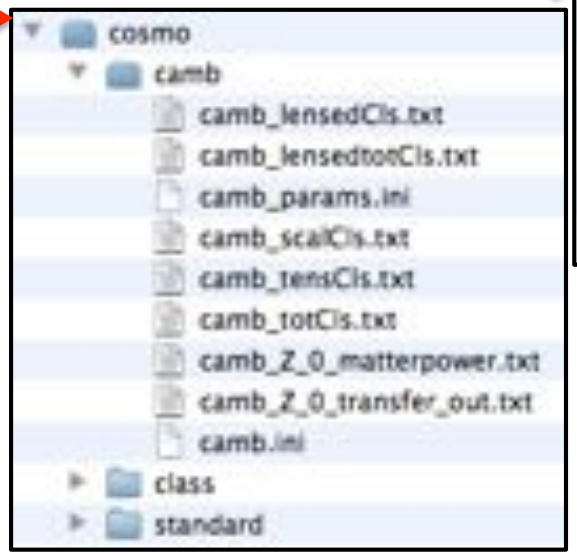
CIB maps


FIRB 217 GHz, 1 deg. resolution
0.035
0.042 MJy/sr

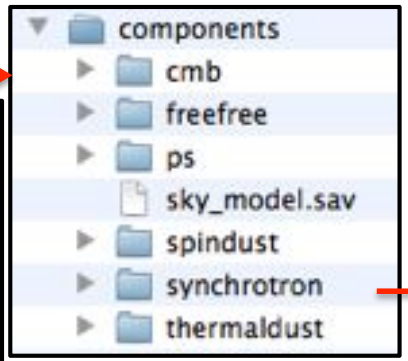

FIRB 857 GHz, 1 deg. resolution
0.59
0.65 MJy/sr

PSM outputs

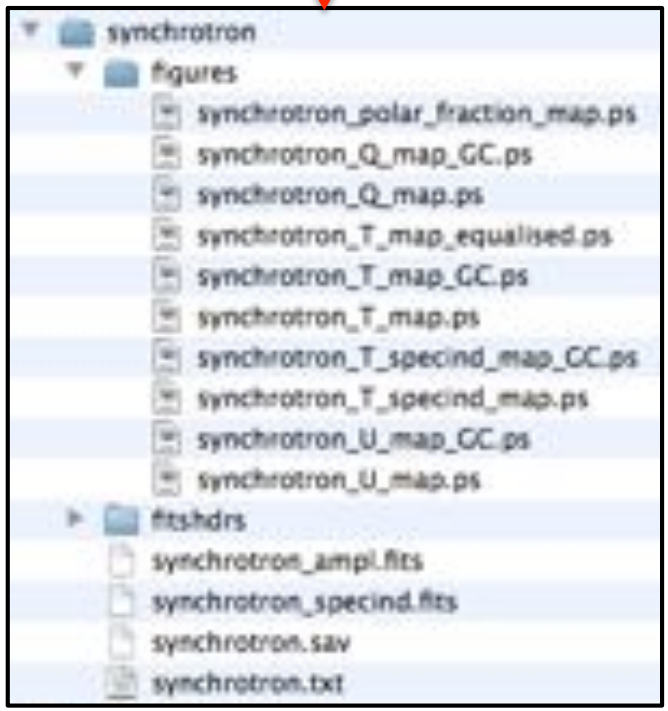




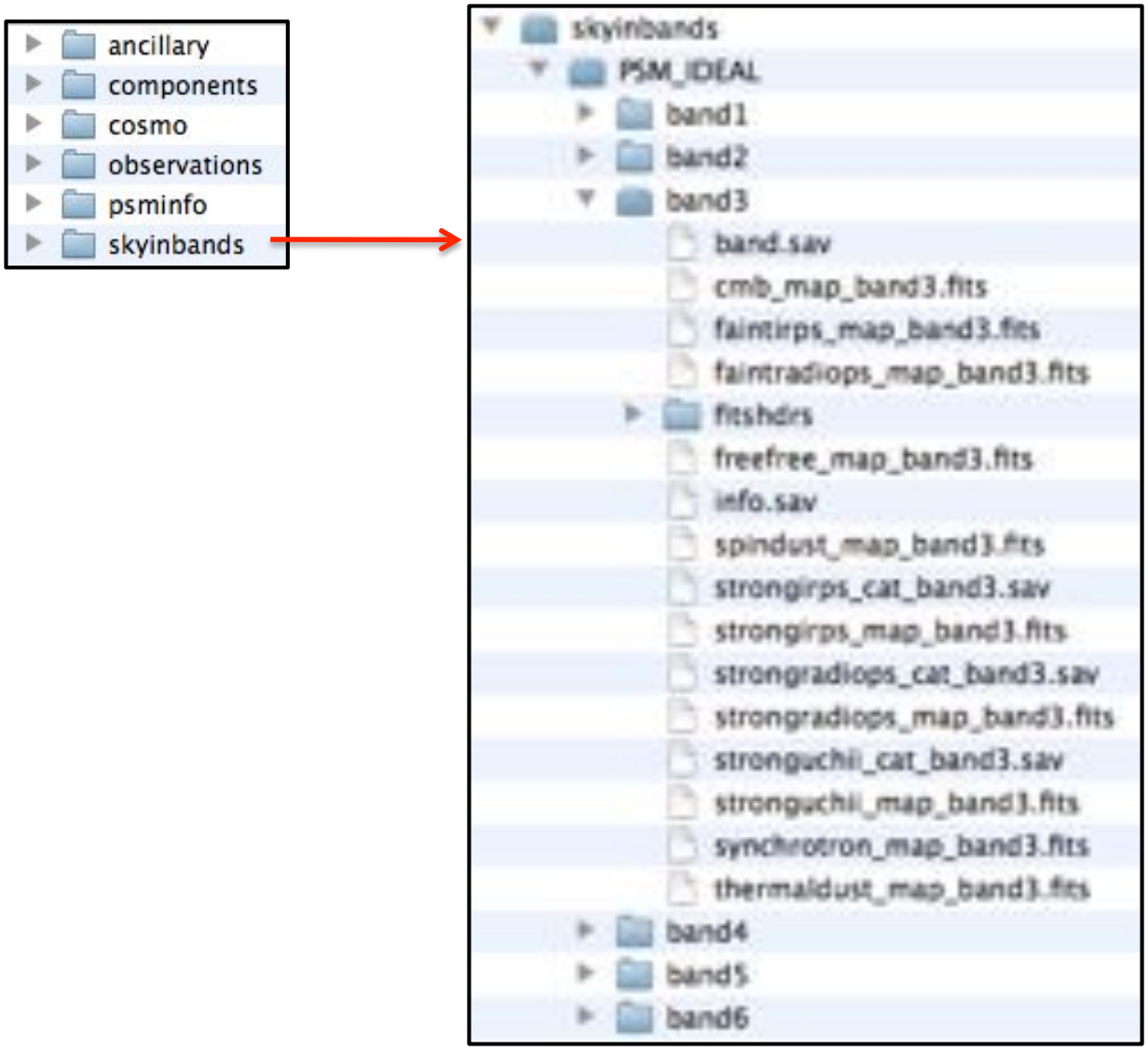
The cosmological background



The parametric model for all components

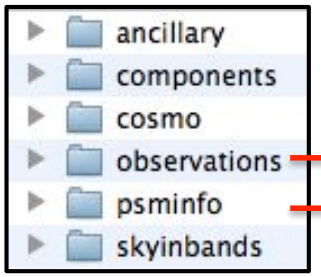


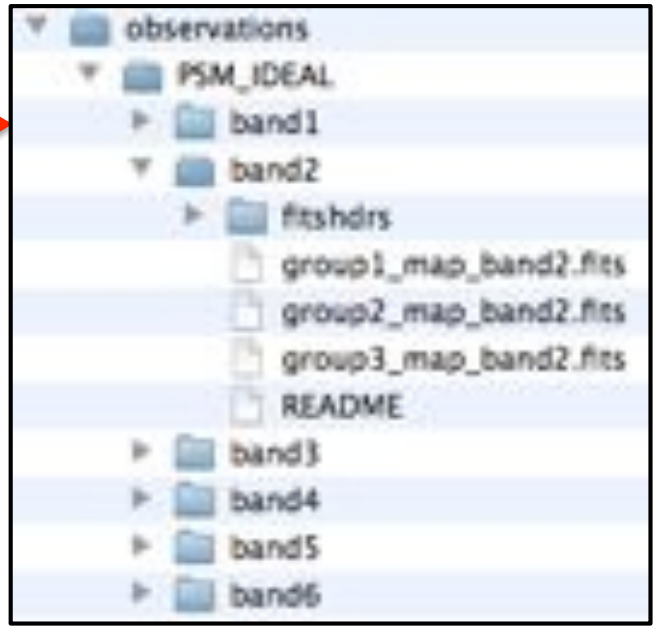
PSM outputs



Maps and/or catalogues of band-integrated emission for all components

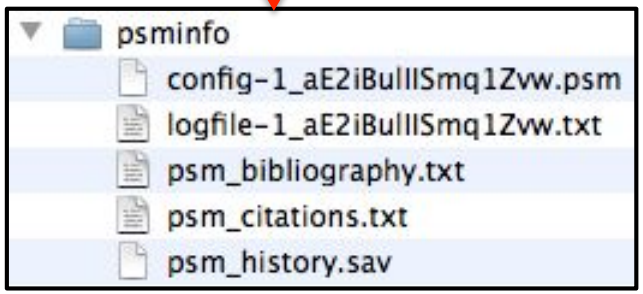
PSM outputs





Output observations

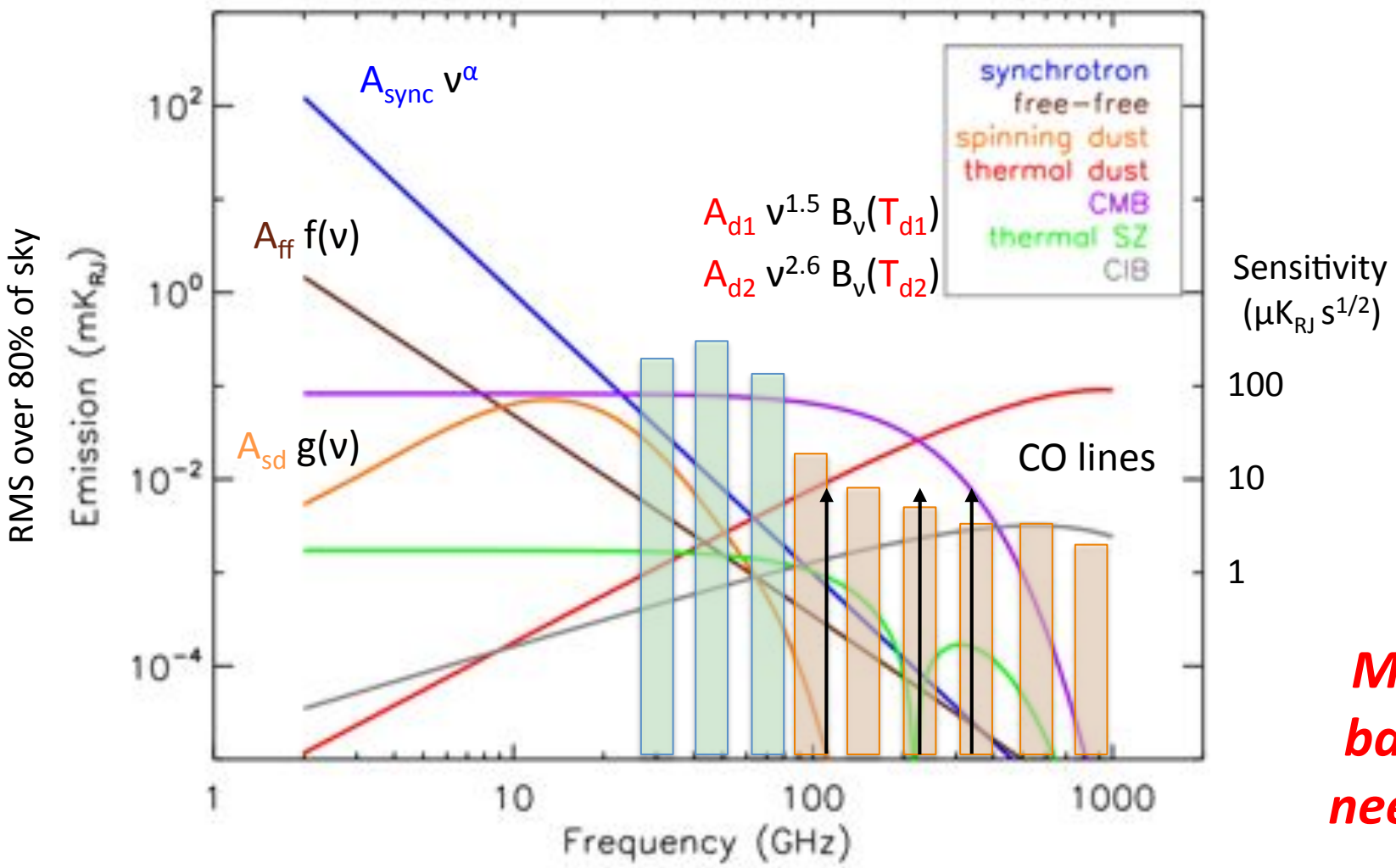
- *Band-integrated*
- *Beam-smoothed*
- *Re-pixelised*
- *Polarised or not*
- *Instrumental noise included*



For traceability

- General philosophy and objectives
- Implementation and status
- Summary

Constraining the model…



More bands needed

What the PSM is and is not

- The PSM is ***NOT***
  - a set of sky emission maps at different frequencies
    - It implements a model (i.e. an interpretation of existing observations)
    - It is very flexible (turn on and off components, effects, noise, options…)
  - the real sky
    - Always check simulations and understand their limits

What the PSM is and is not

- The PSM is
  - A parametric model (keyword: flexibility)
    - Parameters for the cosmological framework and for all components
    - Components are represented using maps of parameters (e.g. map of average dust temperature, map of CMB anisotropies, …), catalogues (e.g. point sources, galaxy clusters), statistical properties (power spectra, number counts, uncertainties, …).
  - Data + code
    - A set of data (observations), together with characterisation and uncertainties
    - Prescriptions to assign values to all the parameters of the model on the basis of these observations, and software tools that implement them
  - A simulation tool
    - code to produce a complete set of component maps and their observation with a set of instruments (not specific to Planck)
    - a library of many useful software tools
  - A ***very useful*** investigation tool
    - For developing "optimal" data analysis pipelines
    - For investigating the impact of varying assumptions and model parameters

The scientific results that we present today are a product of the Planck Collaboration, including individuals from more than 100 scientific institutes in Europe, the USA and Canada

Planck is a project of the European Space Agency, with instruments provided by two scientific Consortia funded by ESA member states (in particular the lead countries: France and Italy) with contributions from NASA (USA), and telescope reflectors provided in a collaboration between ESA and a scientific Consortium led and funded by Denmark.