# Fluctuation Analysis of Point Sources in CMB Maps

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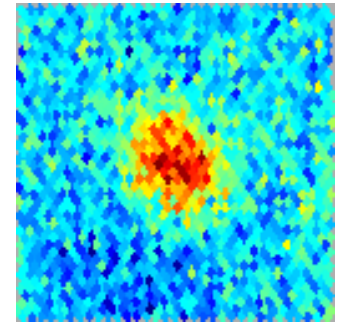
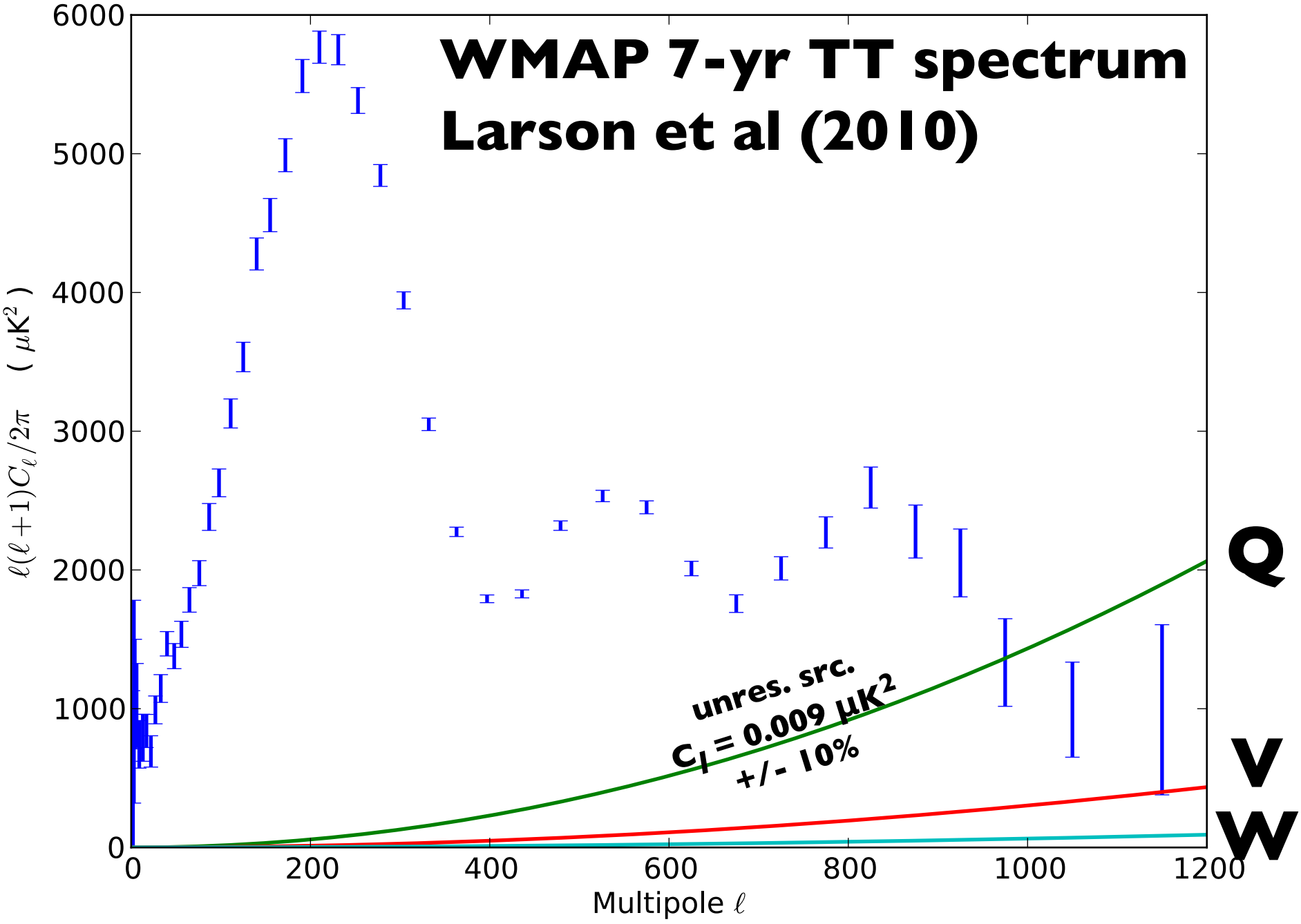
**CMB maps are contaminated by emission from distant galaxies (AGN or DSFG).**




**Mask as many as practical.**

**Faint / unresolved population remains.**

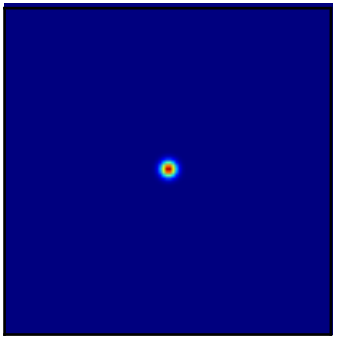
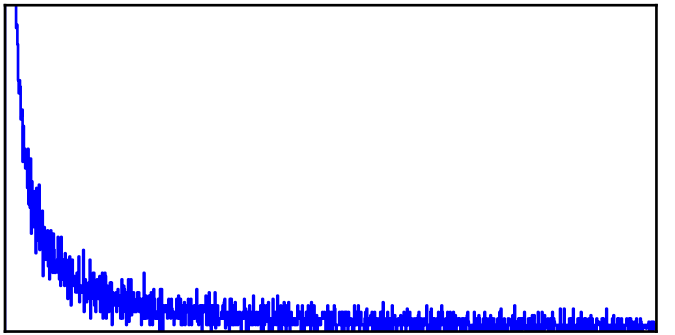
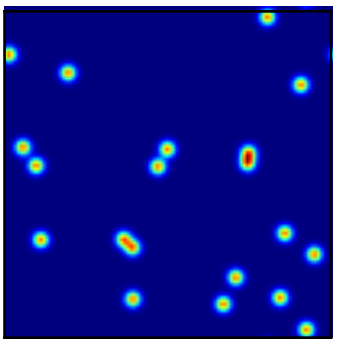
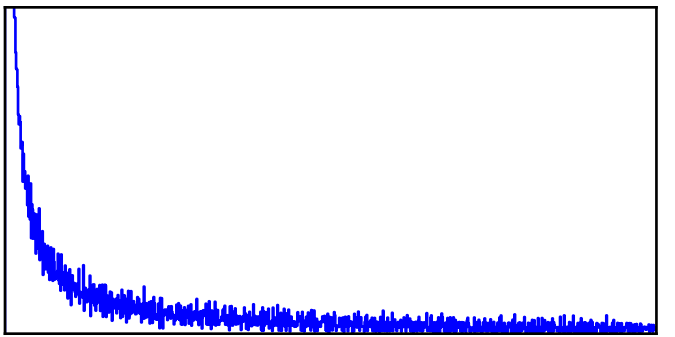
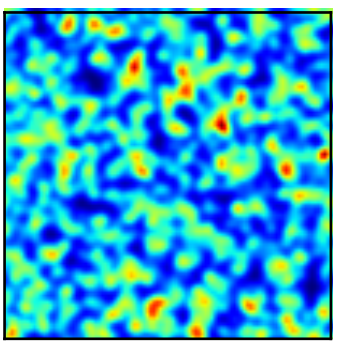
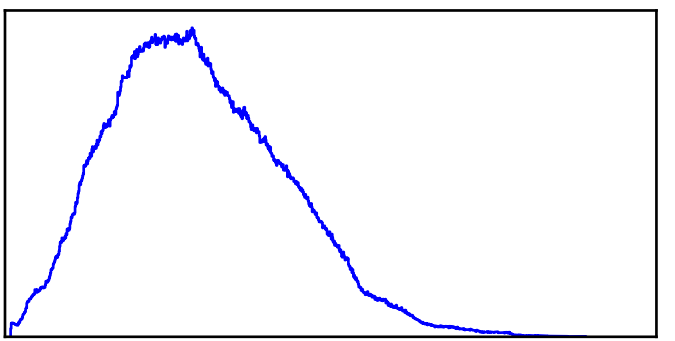

WMAP 7-yr TT spectrum
Larson et al (2010)
$\ell(\ell+1)C_\ell/2\pi$ ( $\mu$K$^2$ )
Multipole $\ell$
0
1000
2000
3000
4000
5000
6000
0
200
400
600
800
1000
1200
unres. src.
$C_l$ = 0.009 μK$^2$
+/- 10%
Q
V
W

**Unresolved sources usually measured by multi-freq. power spectrum & SED.**

**Is harmonic space the best tool?**

**Signal is spatially compact & non-Gaussian.**

**Examine real space PDF.**

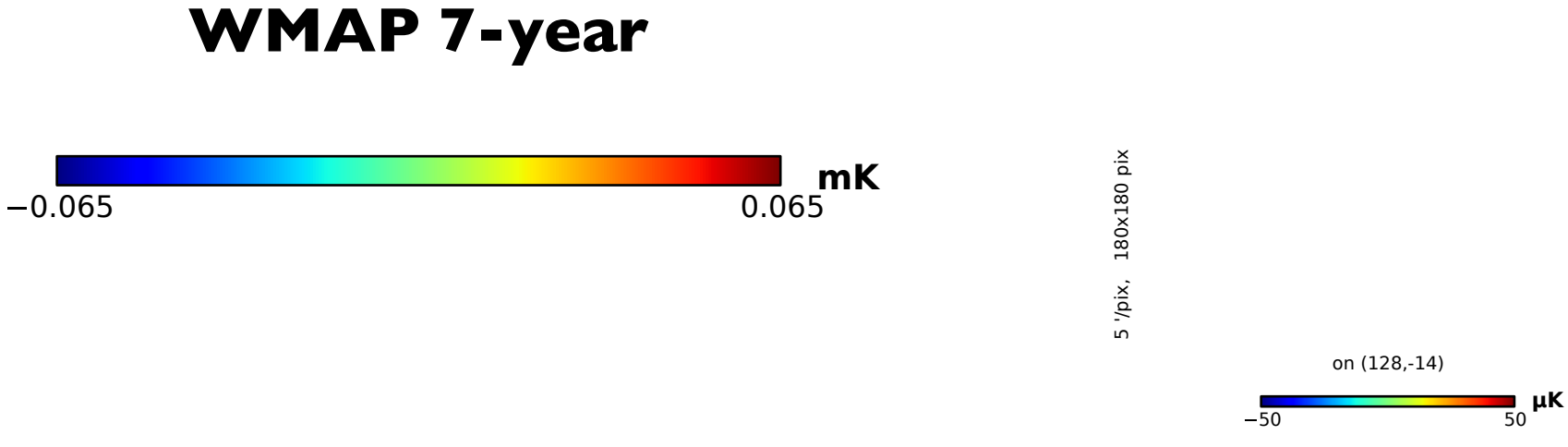
**Fluctuation or P(D) analysis common in sub-mm & radio, where sources can be highly confused.**

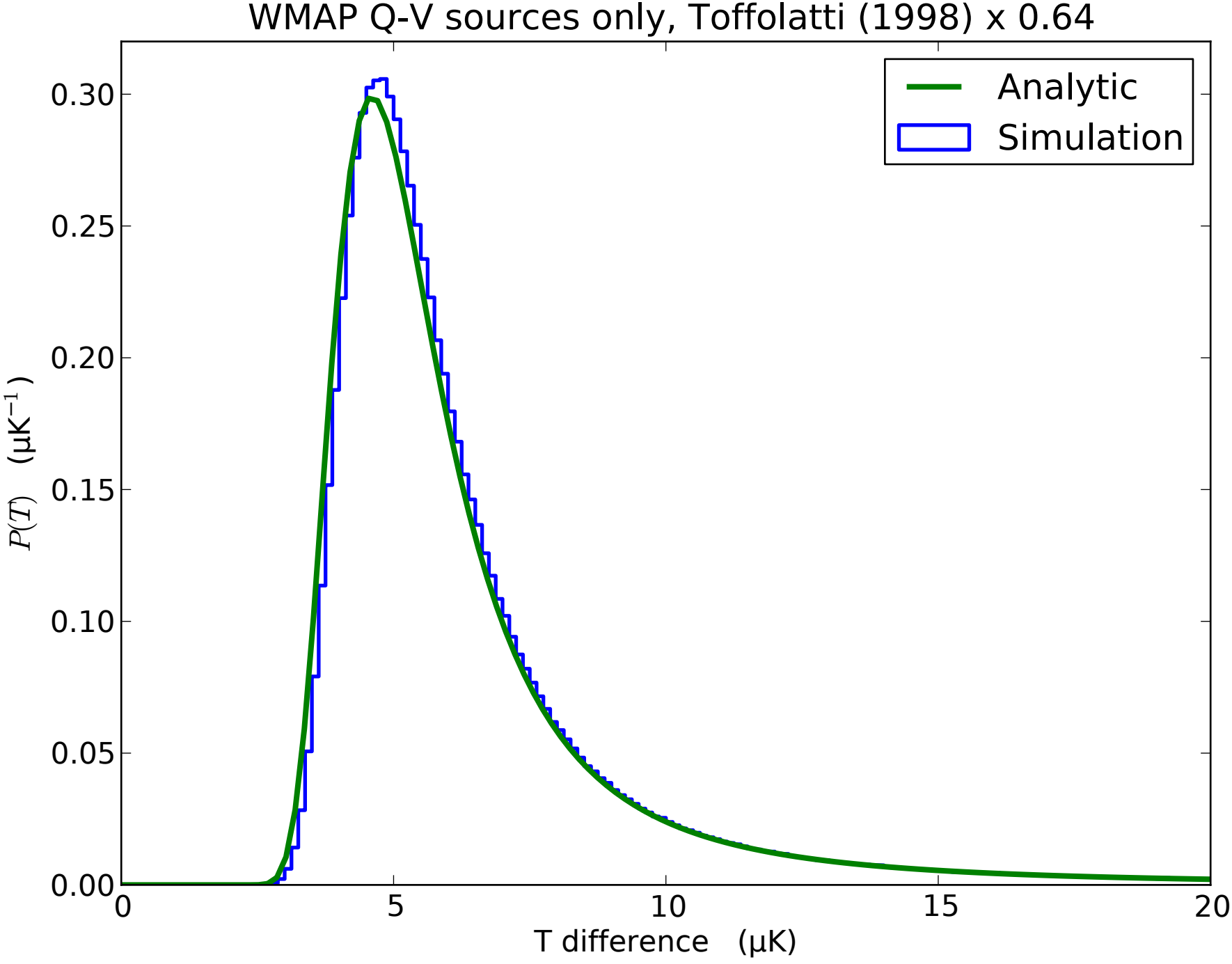
**Compute PDF of a source pop. from beam shape and source counts.**

**Build likelihood to measure sources from pixel histogram.**

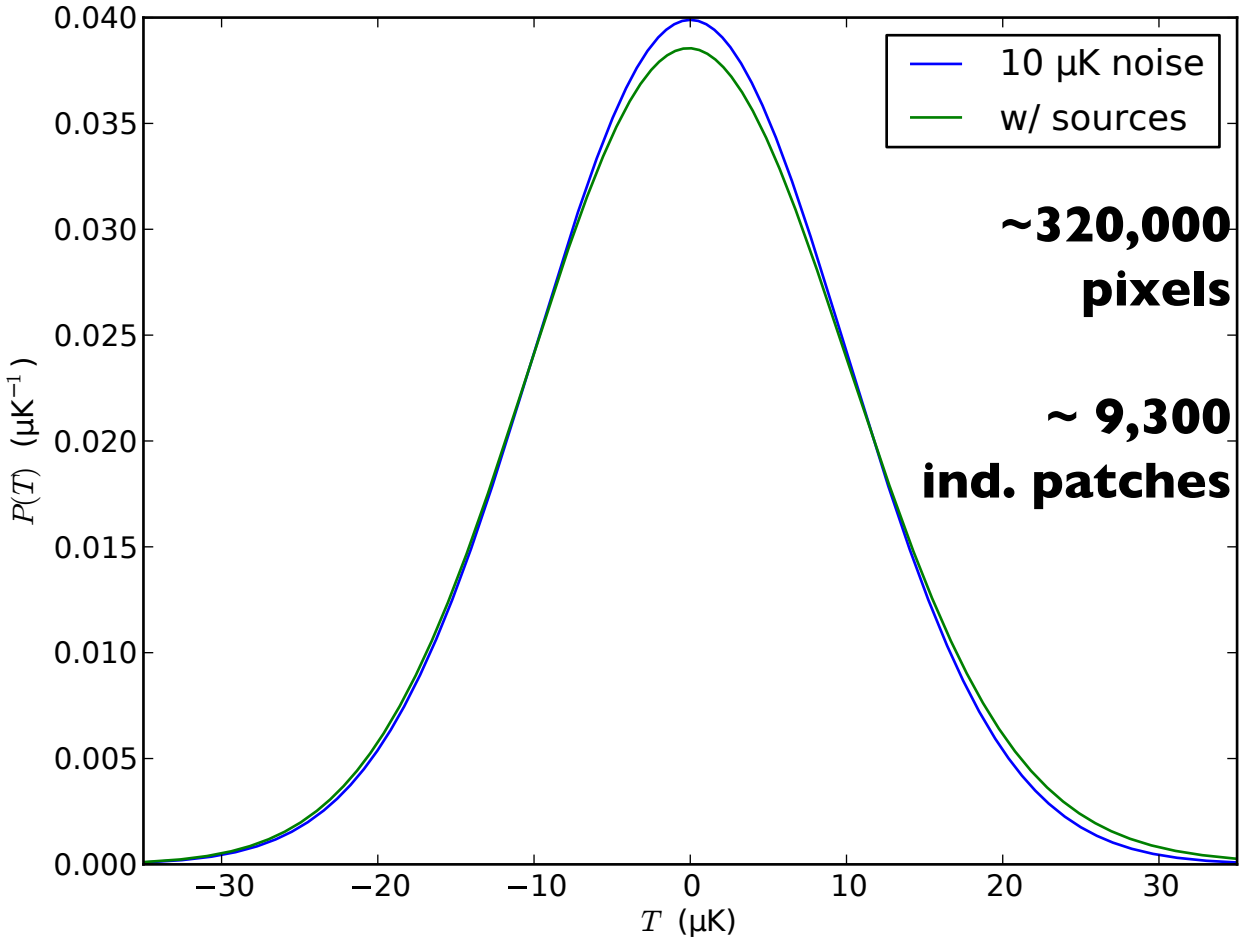
# First, remove the CMB

$$\text{difference map} = b_V * Q - b_Q * V$$
$$= \text{noise} + \text{sources}$$

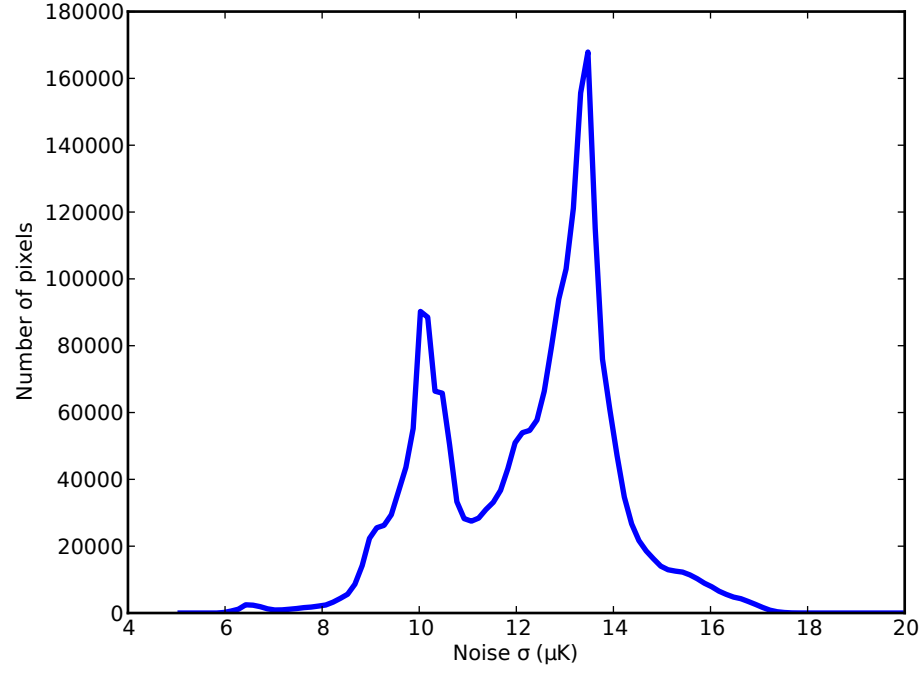



WMAP Q-V sources only, Toffolatti (1998) x 0.64
Analytic
Simulation
0.30
0.25
0.20
0.15
0.10
0.05
0.00
$P(T)$ (μK$^{-1}$)
0
5
10
15
20
T difference (μK)

# Noise

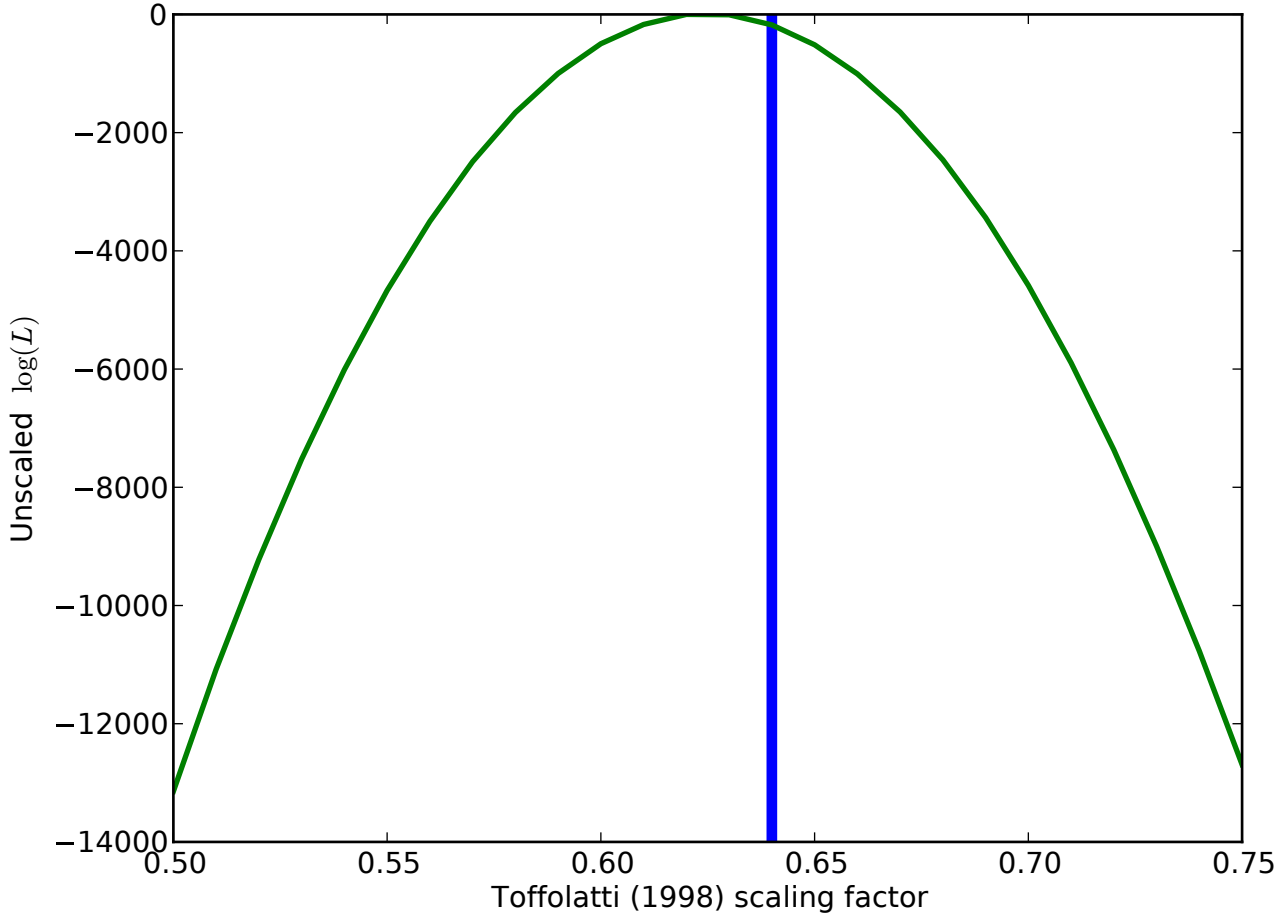

10 μK noise
w/ sources
~320,000 pixels
~ 9,300 ind. patches
$P(T)$ (μK$^{-1}$)
$T$ (μK)
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
−30
−20
−10
0
10
20
30


mK
0.006
0.020


Number of pixels
Noise σ (μK)
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
4
6
8
10
12
14
16
18
20

# Current status

## WMAP sim: one-parameter max. like. recovers counts amp. to 3%.




## Next: Marginalize map mean, required for real data.

# Future directions

**Sources in Planck & ACT data**
**(Including clustering)**

**Unresolved SZ clusters**
**(Negative sources & multiple profiles)**

**PDF of map products?**
**(Address noise uncertainties)**

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