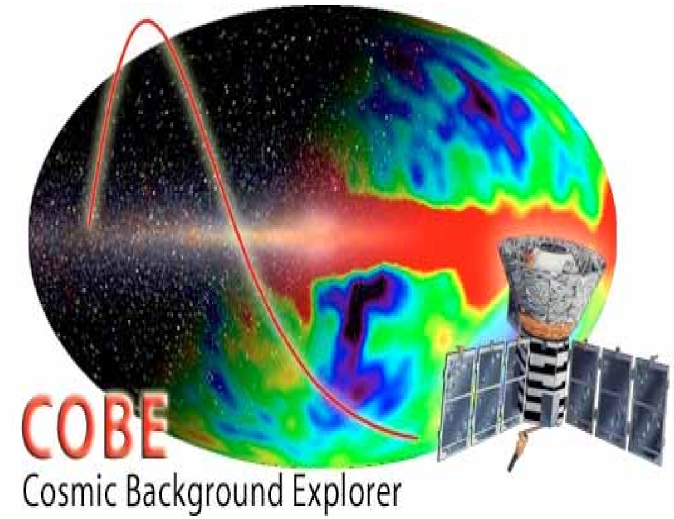
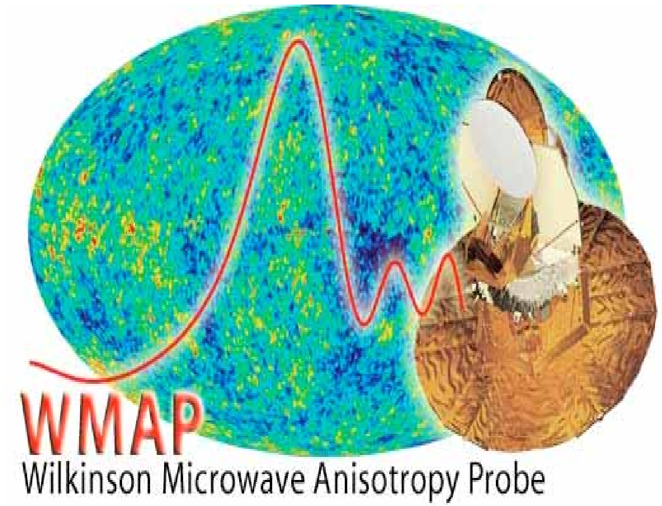
On the bispectrum of



and



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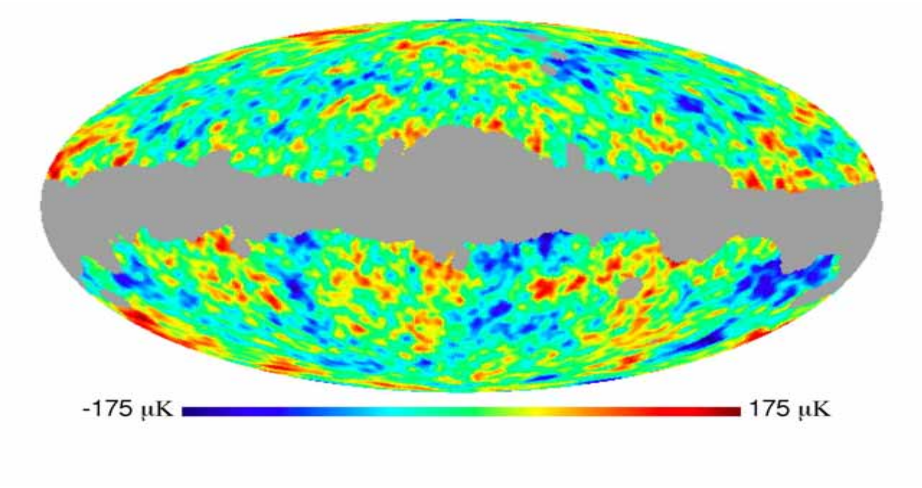
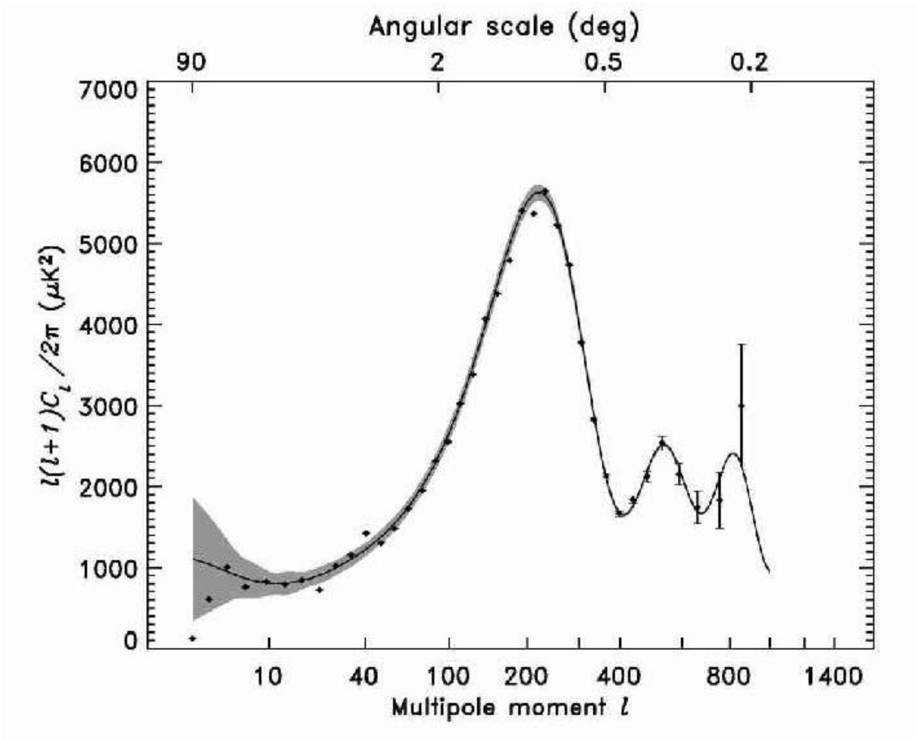
Gaussianity

Map =
CMB+Foregrounds +
Noise + Systematics





CMB = Gaussian Random Field ?

- Inflation predicts gaussian fluctuations
- Gaussian assumption simplifies calculations
- All information on power spectrum

Why/How pursue non gaussianity?

- Non gaussian sources:

Foregrounds

Systematics

Non linear effects

Secondary anisotropies

Non trivial topologies

- Testing gaussianity

infinite degrees of freedom

cosmological origin ?

tools:
- higher order moments

- topological tools

...

On the bispectrum:

1. Spherical Harmonic decomposition

$$\frac{\Delta T}{T}(\mathrm{n}) = \sum_{\ell m} a_{\ell m} Y_{\ell m}(\mathrm{n})$$

2. Cubic invariant (bispectrum) estimator

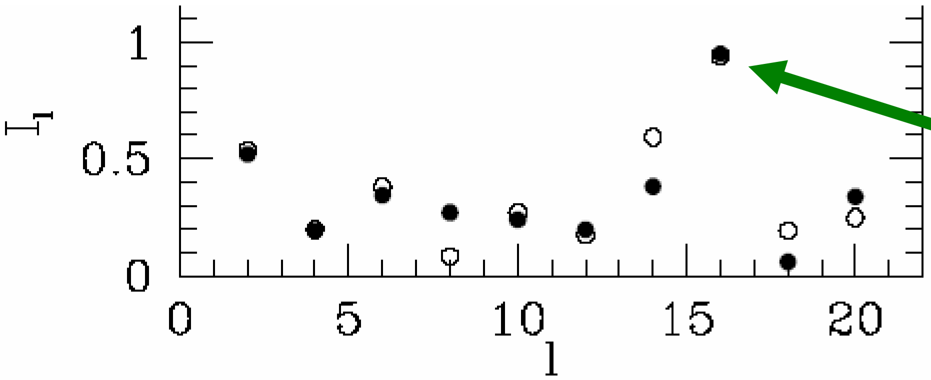
$$\hat{B}_{\ell_1 \ell_2 \ell_3} = \frac{\begin{pmatrix} \ell_1 & \ell_2 & \ell_3 \\ 0 & 0 & 0 \end{pmatrix}^{-1}}{(2\ell_1+1)^{\frac{1}{2}}(2\ell_2+1)^{\frac{1}{2}}(2\ell_3+1)^{\frac{1}{2}}} \times \sum_{m_1 m_2 m_3} \begin{pmatrix} \ell_1 & \ell_2 & \ell_3 \\ m_1 & m_2 & m_3 \end{pmatrix} a_{\ell_1 m_1} a_{\ell_2 m_2} a_{\ell_3 m_3} \qquad (2)$$

3. Normalized bispectrum (selection rules)

$$I_\ell^3 = \frac{\hat{B}_\ell}{(\hat{C}_\ell)^{3/2}} \quad \text{and} \quad J_\ell^3 = \frac{\hat{A}_\ell}{(\hat{C}_{\ell-1})^{1/2}(\hat{C}_\ell)^{1/2}(\hat{C}_{\ell+1})^{1/2}}$$

The story of a non gaussian signal …

Ferreira, Magueijo, Gorski (1998) – COBE 4 y



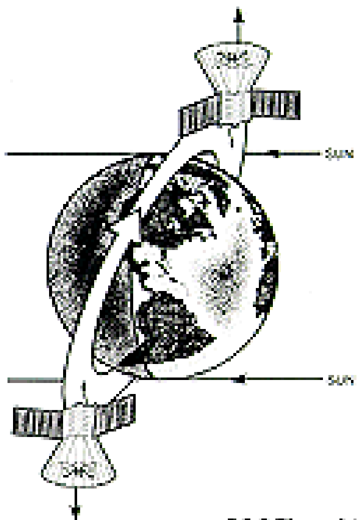
Single l bispectrum:

dominant l=16 signal

Banday, Zaroubi, Gorski (1999)

systematic effect responsible for signal

-> eclipse data



COBE's Orbit

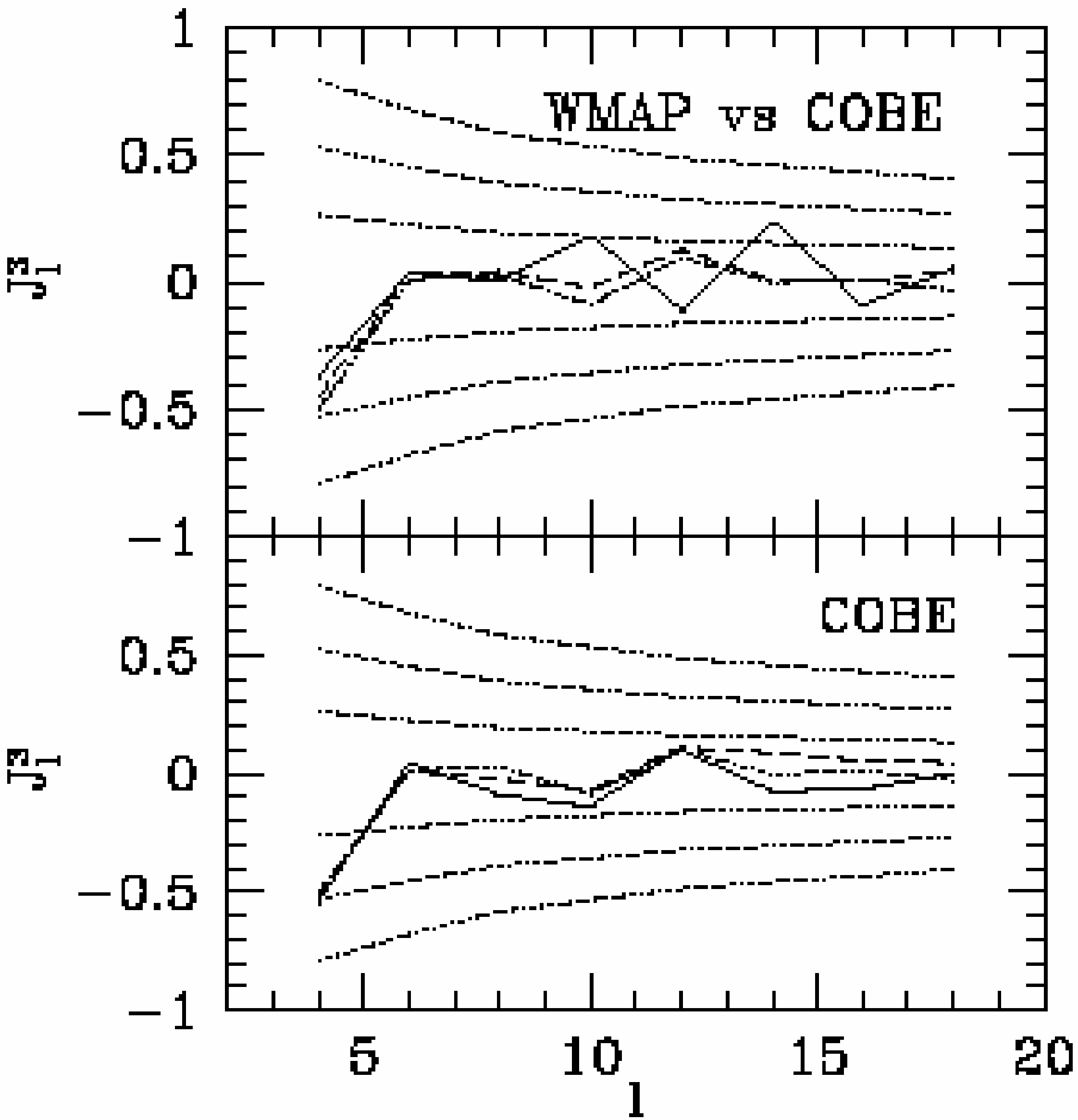
Magueijo(2000) – COBE 4 y

Δl = 1 normalized bispectrum

- Strong signal on all scales ;
- Very low chi squared;

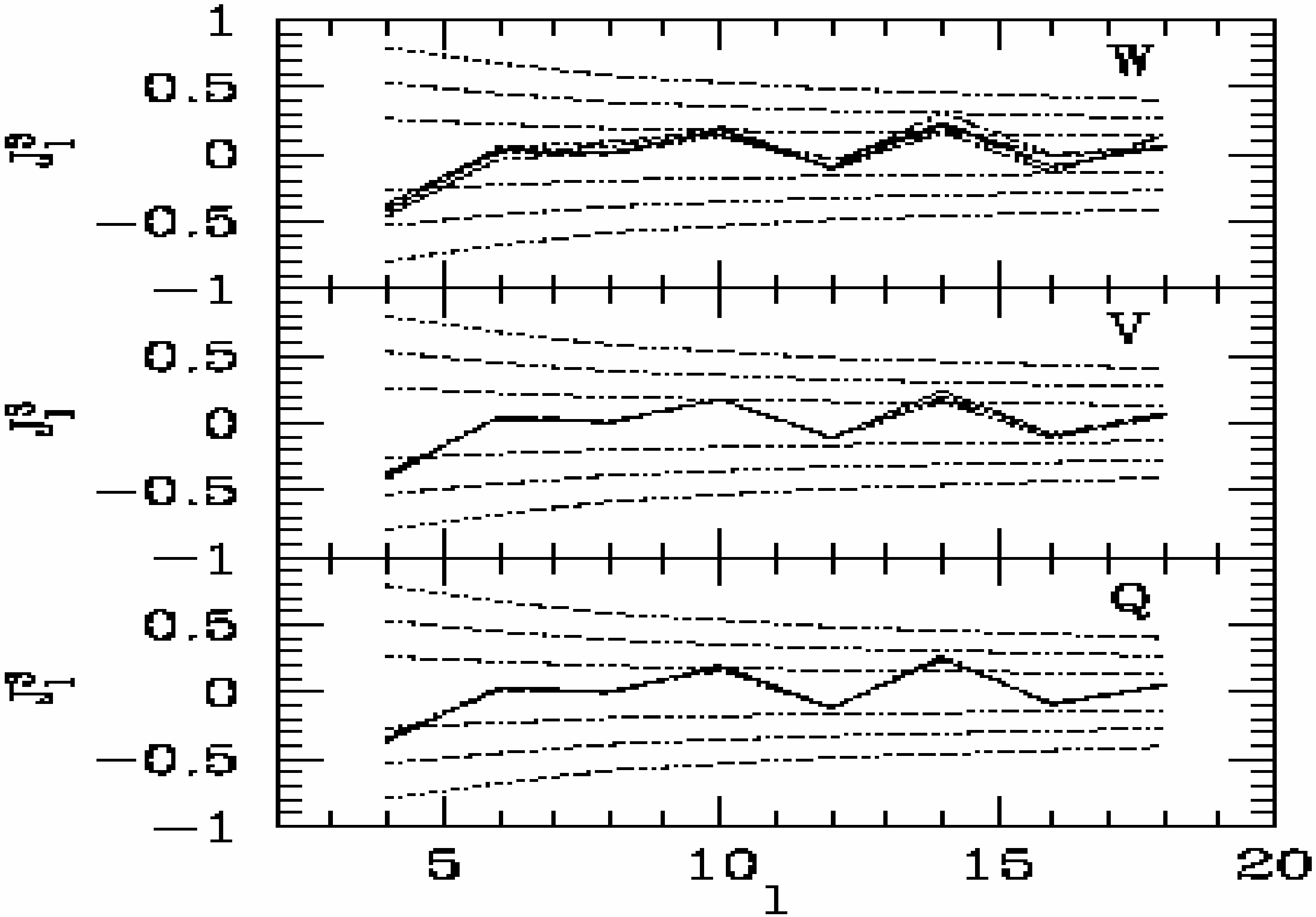
	J_4^3	J_6^3	J_8^3	J_{10}^3	J_{12}^3	J_{14}^3	J_{16}^3	J_{18}^3	X^2	Reject %
Gauss-rms	.263	.225	.194	.178	.162	.153	.144	.135	—	—
DMR - ecl	-.521	.009	-.022	-.007	.112	.088	.054	.045	.22	98.5
DMR - gal	-.502	.012	.029	-.088	.098	-.002	.013	-.030	.14	99.8

INTER - L BISPECTRUM : WMAP and COBE



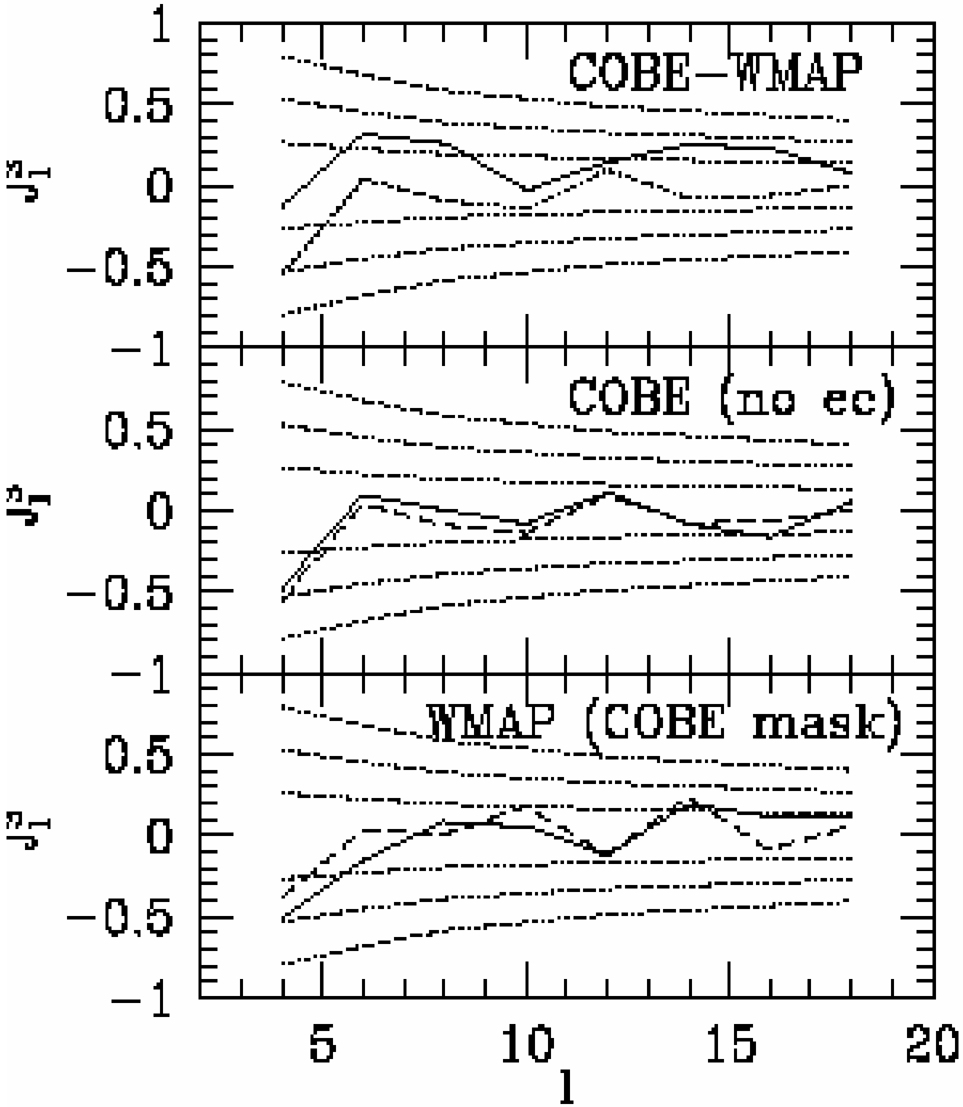
WMAP	χ^2
HEALPix (galactic)	0.59
COBE	χ^2
Quadcube (galactic)	0.14
Quadcube (ecliptic)	0.22
HEALPix (galactic)	0.26

INTER - L BISPECTRUM : WMAP frequency channels



-> No frequency dependence

INTER - L BISPECTRUM : the why of COBE's non gaussianity ?



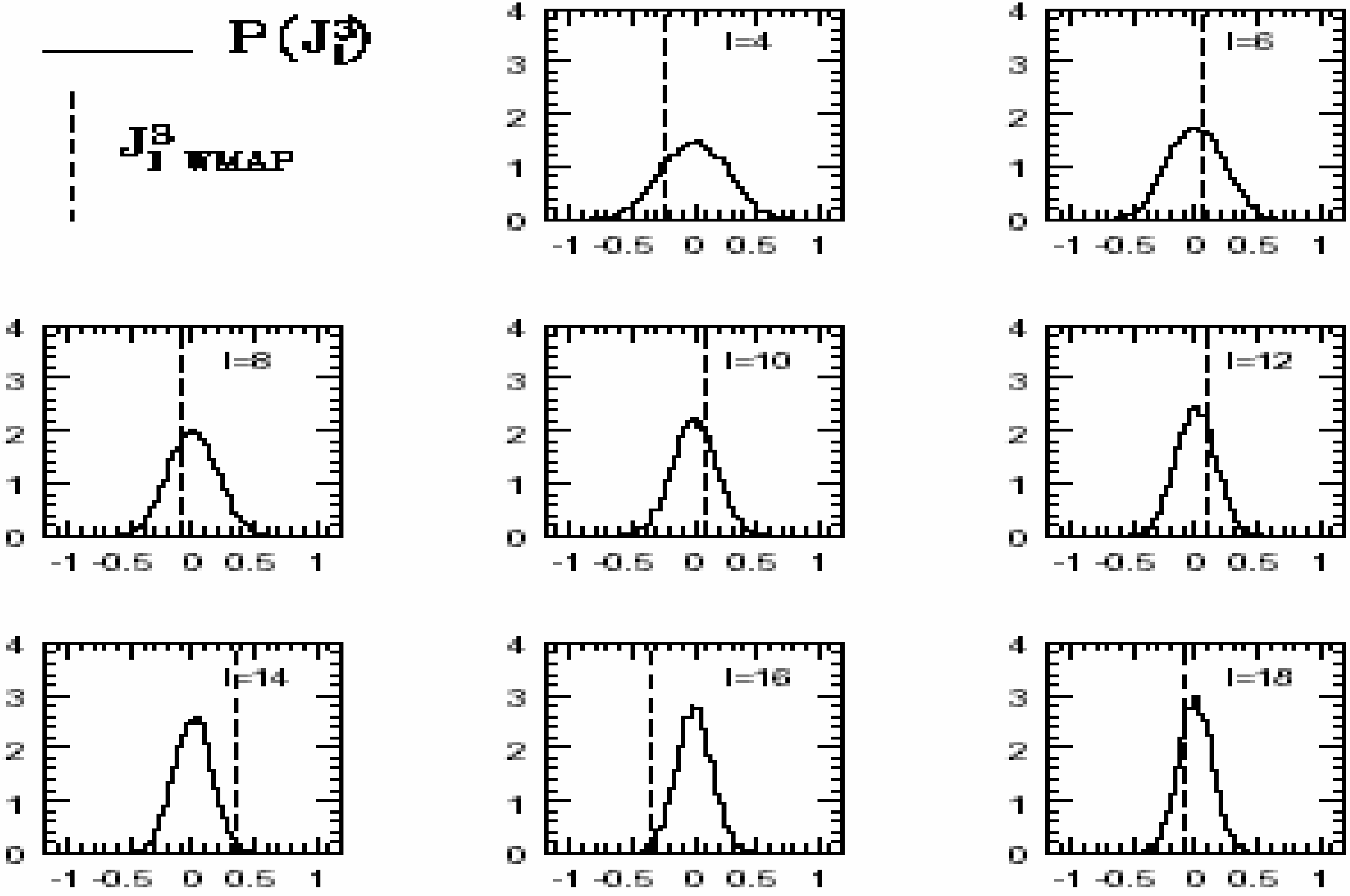
Difference Map:
no correlation
with signal!

COBE (HEALPix without eclipse data):
$\chi 2 = 0.42$

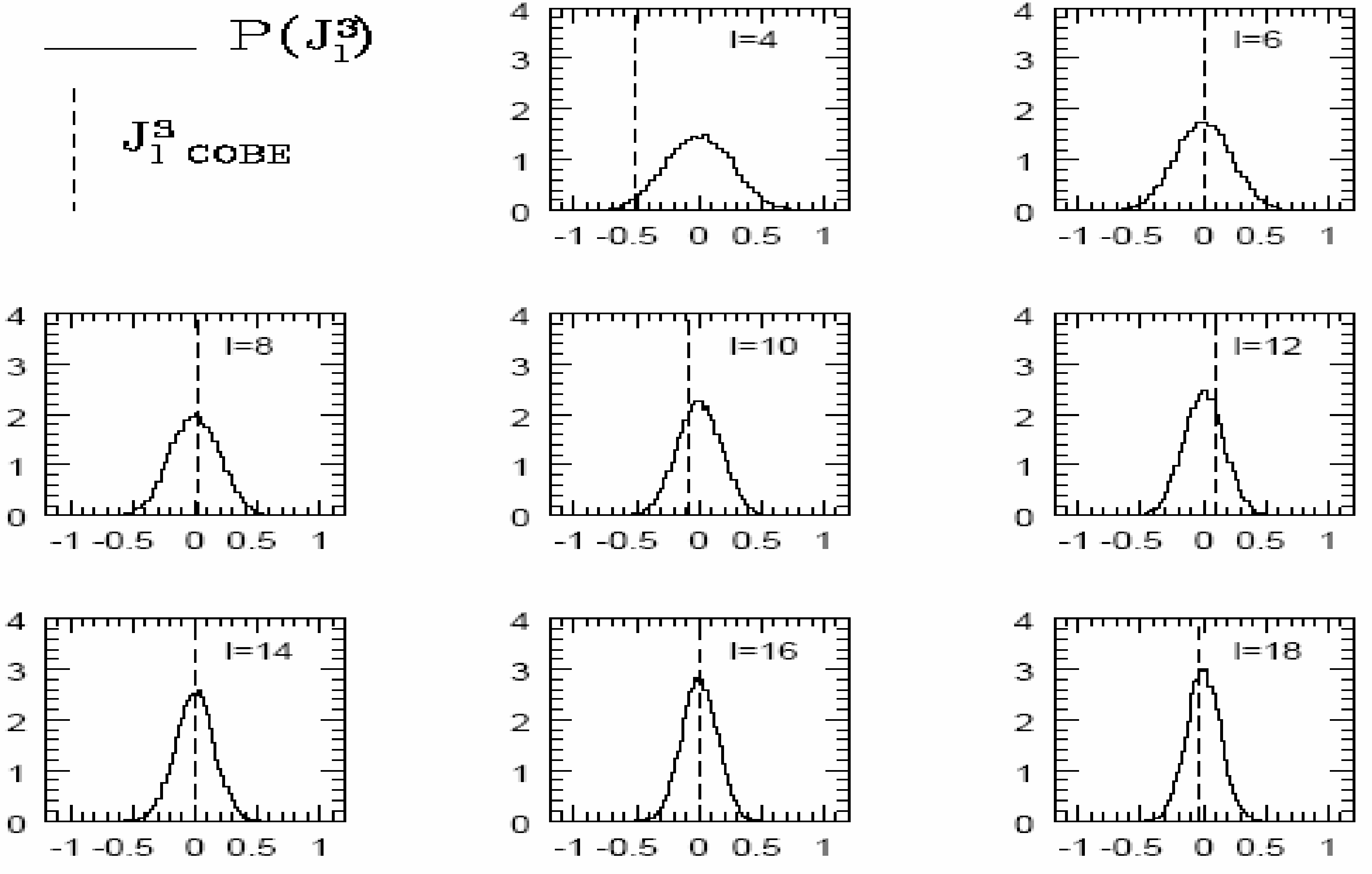
-> Gaussian consistent!

Mask?
-> Cobe mask : $\chi 2 = 0.64$
-> Kp0 : $\chi 2 = 0.59$

WMAP



COBE



CONCLUSIONS

- Bispectrum of WMAP is consistent with gaussianity.
- Non gaussianity of COBE due to combination of systematic effect + pixelization scheme.