The Planck-HFI Early Compact Source (ECS) Catalogue

F. R. Bouchet & J.-L. Puget

Version 1 (1st Draft)

1 Characteristics of the HFI-ECS catalog

The ECS catalog will be obtained (see Document PL-HFI-IAS-TN-ECS01, V0.1.2) by first extracting potential candidates by high-pass filtering individual detector's time-lines, then confirming or infirming the detection by cross-comparing all nearby scans in the small areas where potential sources cluster. If a source is confirmed, the corresponding local map is used to get the position and the flux of the source.

The threshold for inclusion in the ECS is thus the detection threshold along a circular scan, σ_{ECS}, which is taken to be 2.5 times the scan noise, σ_{scan}. On a scan, the detection threshold as compared to the nominal one is increased since the integration time is reduced by approximately

- a factor $\sim$ two due to loss of redundancy from crossing trajectories
- a factor $\sim$ eight due to the reduced (1) number of detectors
- a factor two due to one sky survey instead of two

which implies a factor ~ 32 in time, i.e. $\sigma_{scan} \simeq 4 \times \sqrt{2}\, \sigma_{nominal}$, where $\sigma_{nominal}$ stands for the final sensitivity of a given channel.

With the assumed instanteous extraction threshold σ_{ECS} of 2.5 σ_{scan} = 14 $\sigma_{nominal}$, this leads to

ν	σ_{ECS}
100 GHz	120 mJy
143 GHz	120 mJy
217 GHz	160 mJy
353 GHz	280 mJy
545 GHz	620 mJy
857 GHz	620 mJy

Of course, once potential sources have been flagged ("extracted") as 2.5 $sigma_{ECS}$ fluctuations, since all detectors are used to confirm or infirm the detection, and get position and flux, the reliability of the ECS catalog will be closer to that of a catalog of sources extracted at $2.5 \times \sqrt{8}\sigma \sim 7\sigma$.

Note that the threshold for inclusion in the ECS catalog would be ~ 3.7 times worse than the final release source catalog, as judged by comparison with the detection limit of ~ 75 mJy at 350 GHz obtained by the Maximum Entropy component separation of Hobson et al. (cf. fig 1) on simulated maps of observations by Bouchet & Gispert sparkled with sources according to the model of Toffolati et al.

Scientific uses of the ECS:
This catalog will be rather unique for galactic studies (cold molecular clouds...) Note that given the relatively high threshold, only a small number of sources will be of interest for cosmology, i.e. the very rare ones (i.e. the Ultra-Luminous ones) likely to be at significant redshift (typically $\sim$ 2-3, as could be anticipated from flux ratios in the Planck spectral bands, akin to "photometric redshifts"). This fraction should be comparable to what was found in the IRAS survey.
The specific case of clusters is adressed below in $.3

2 A Deep Early Compact Source Survey - DECS

For cosmology, a more interesting early product would be the creation of two small maps in very high redundancy regions, i.e. around the ecliptic poles for any reasonnable Planck scanning strategy (plus possibly a few more areas, depending on the scanning strategy retained).

The idea would thus be to create (using all detectors at a given frequency) about 2 maps 14×14 degrees with an integration time ~ 6 times larger than nominal, i.e. with an integration time 3 times larger than the final survey (this is based on one sky survey instead of two).

These high frequency "maps" geared at source detection would be obtained by simply removing a baseline (on the ~ 14 degree scale) to the relevant pieces of each detector scan circle data before a simple pixel projection. Since this DECS survey would have a detection threshold about $\sim \sqrt{3}$ worse than the final processed one, the DECS catalog in these high redundancy region would have about the nominal sensitivity of the final all-sky Planck survey. This thus leads to

ν	σ_{DECS}
353 GHz	100 mJy
545 GHz	220 mJy
857 GHz	220 mJy

Table 1: DECS survey sensitivity over a surface $\sim 1\%$ of the sky.

3 The specific case of clusters

Concerning clusters detected by their Sunyeav-Zeldovich signature, the threshold of 100 mJy at 353 GHz translates into about an integrated y (on the cluster profile) of about 6.7×10^{-4} arcmin^2 (i.e. a peak y of typically $\sim 10^{-5}$). In the most pessimistic case of an $\Omega_{matter} = 1$, this leads to a density of 0.3 sources per square degrees (cf e.g. Barbosa et al.) or about 240 clusters in the Deep quick look catalog. If Ω_{matter} turns out to be closer to 0.3 (as suggested e.g. for current CMB data and clusters and Supernovae), the density could increase by as much as ~ 7.

Note that in the normal ECS (i.e. over the full sky), there would be a detection threshold higher than in the deep one by a factor 2.8 at 350 GHz, i.e. a number density smaller by a factor $2.8^{1.5} \sim 5$ over an area 100 times larger, thus this catalog should contain $> 240 \times 20 \sim 5000$ clusters! This is certainly another rather valuable product of the Quick Look source catalog.

4 Summary

ν	Detection threshold		Number of galaxies		Number of clusters	
	Full sky	Deep 1%	Full sky	Deep 1%	Full sky	Deep 1%
353 GHz	280 mJy	100 mJy	7000	500	5000	240
545 GHz	620 mJy	220 mJy	5000	400		
857 GHz	620 mJy	220 mJy	14000	1100		

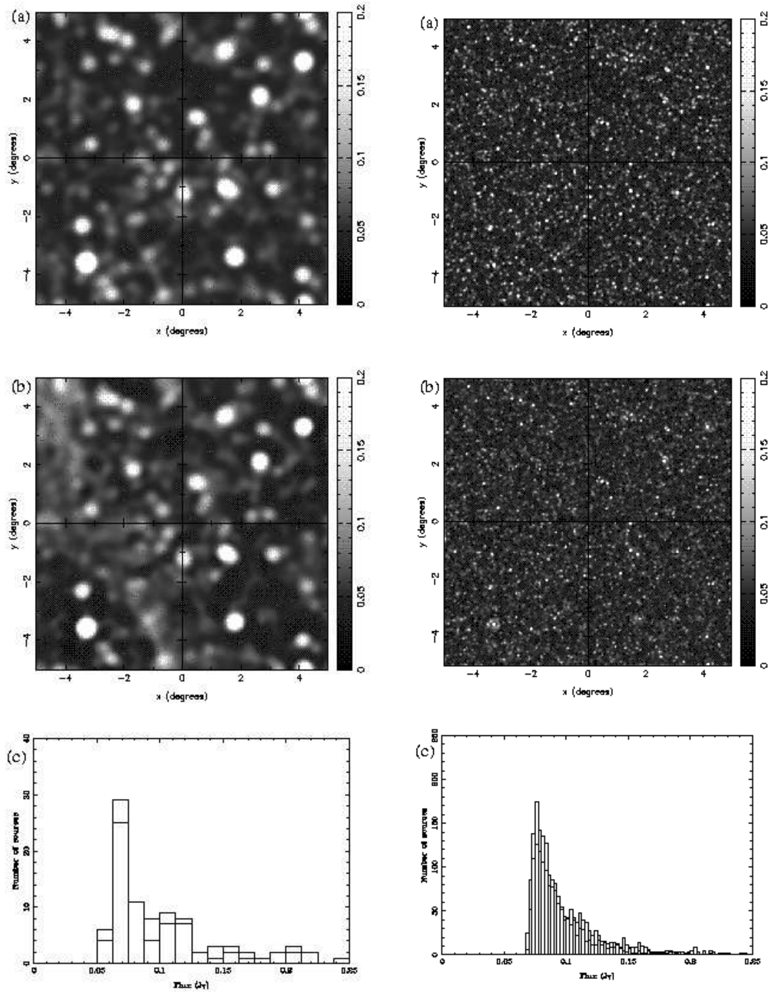

Figure 1: 44 GHz & 353 GHz channel of Planck. Top: input source maps at the appropriate resolution in Toffolati & al. model. Middle: MEM recovered source map at the same frequency. reay scales denote the flux density in Jy. Bottom: comparison of input and output source counts obtained using SExtractor.

Figure 1: From Hobson M., Barreiro R. B., Toffolati L., Lasenby A. N., Sanz, J. Jones A. W., Bouchet, F. R., 1999, MNRAS, **306**, p.232