Release Note

Herschel Confusion Noise Estimator update patch v019

HERSCHEL-HSC-DOC-1678

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May 19, 2010

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1 HCNE/v019 status summary

The current version of the Herschel Confusion Noise Estimator (version 019) uses the same base code and logics in calculating the confusion noise as the previous officially released version (v015), therefore we refer to the v015 release note in most aspects of the current version. Only the changes relative to version 015 are described in this present release note.

The modification with respect to HCNE/v015 are the following:

1 Correction for the constant interstellar medium temperature in the determination of the cirrus component of the background surface brightness

2 Modified scaling of cirrus confusion noise with surface brightness based on the measured structure noise in a set of PACS red band (160 μm) "MadMaps".

3 Updated extragalactic background confusion limit values based on the first Herschel-PACS and Herschel-SPIRE numbers.

The changes are described in detail below.

2 Cirrus temperature correction

The surface brightness value at a specific wavelength and sky position (that is necessary for the determination of the cirrus component of the confusion noise) is obtained using the Herschel Background Estimator (HBE). HBE assumes a unique temperature for the cirrus component all over the sky that makes the estimates unreliable in some cases.

To overcome this issue, we apply a sky coordinate dependent temperature correction in HCNE/v019. This correction uses the COBE/DIRBE maps to get the corrected temperature values, with the help of the *Predict-DIRBE* tool. *PredictDIRBE* is described in detail in the Appendix of Kiss et al. (2006).

3 New cirrus scaling at 160 μm

In addition to the cirrus component, the instrument noise and the confusion noise due to the extragalactic background are considered, and together they give the full strucuture noise that can be determined in a map. The instrument and extragalactic parts are constant for a specific wavelength and AOR, and do not depend on the actual surface brightness. Only the cirrus component scales with the surface brightness, and hence the surface brightness can be used to characterize the cirrus confusion noise. The previous versions of HCNE were still based on low spatial frequency, mostly Infrared Space Observatory data that was scaled to the spatial frequencies of the Herschel detectors and wavelengths. For the present version, however, we processed a set of MadMaps, obtained at various average surface brightness levels, in order to determine the surface brightness dependence of the cirrus component from real measurements at the real spatial scales of the Herschel photometric observations. All the maps we used for HCNE/v019 were taken with Herschel-PACS at the 160 μm band, where the cirrus component should be the most prominent. The strucure noise values obtained were fitted with a function that contained a cirrus component with scaling parameters to be determined and, in addition, the contribution of the instrument noise and extragalactic confusion noise components (for this latter one see Section 5). The cirrus scaling derived from this data replaced the previous cirrus confusion noise – surface brightness scaling in HCNE/v019.

4 Conversion to other wavelengths

Since we had real measured structure noise and confusion noise values at 160 μm only, it was necessary to transform these cirrus confusion noise values to the other Herschel photometric bands.

In theory, the wavelength scaling (not considering differences in the surface brightness due to the spectral energy distribution of cirrus) should be $N_\lambda = N_{\lambda_0}(\lambda/\lambda_0)^{1-\alpha/2}$ (see e.g. Kiss et al, 2005, for details).

where α is the spectral index of the spatial power spectrum of the map. For the "classical" cirrus, a spectral index of –3 was generally assumed, however, this canonical value has changed slightly, and recent works indicate a spectral index of ≈–2.5. The theoretical scaling is valid for the diffration limited case, and the scaling may differ to the real PACS and SPIRE instruments, especially for the PACS blue detector, where the same detector array is used with two filters.

We have checked this scaling with synthetic images that had a prescribed spectral index of –2.5. The original fine structure images were convolved with the respective PACS and SPIRE PSF-s, and sampled to get images with the real pixel scales of the instruments. For this analysis a "flat" cirrus spectral energy distribution was assumed, i.e. the final images had the same average surface brightness values in [MJy/sr] in all bands. Then the

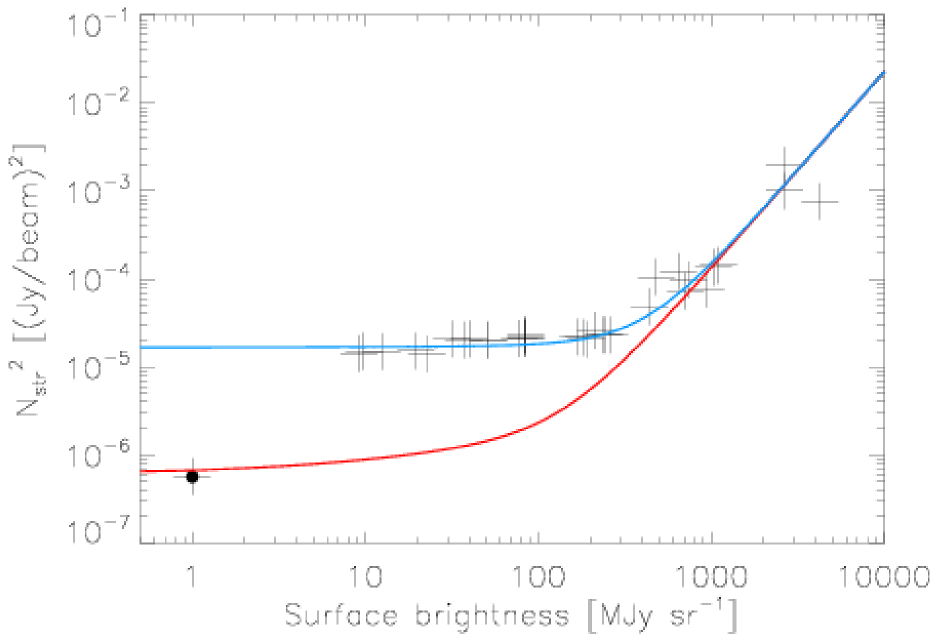

Figure 1: Structure noise in the present MadMap sample at 160 μm as a function of surface brightness (plus signs). The extragalactic background confusion noise point is indicated by a big black dot. The blue curve represents the fitted structure noise considering the instrument noise, while the red curve represents the fitted sum of cirrus and extragalactic components (structure noise without the instrument noise).

structure noise was determined for all images. We used the PACS red band image as reference (that is where we have measured structure noise information, see the previous section). The theoretical conversion coefficients and their correction factors (based on the simulated map results) are listed in Table 1 below.

λ (μm)	70	100	170	250	350	500
$(\lambda/\lambda_0)^{1-\alpha/2}$	0.155	0.347	1.0	2.729	5.819	12.984
R_λ	1.099	0.856	1.0	1.334	1.259	1.210

Table 1: Coefficients to convert PACS red band cirrus confusion noise to the Herschel photometric bands (without surface brightness correction). The cirrus confusion noise is then obtained as: $N_\lambda = N_{160} \cdot R_\lambda \cdot (\lambda/\lambda_0)^{1-\alpha/2} \cdot f^{\lambda}_{cirr}(B_\lambda)/f^{160}_{cirr}(B_{160})$

5 New extragalactic background confusion limits

Herschel has already obtained its first results concerning the extragalactic background and gave the first extragalactic confusion noise limit values. The new values are implemented in HCNE/v019, as summarized in Table 2 below.

λ (μm)	70	100	170	250	350	500
N_{CIB} (mJy)	0.024^a	0.1^b	0.75^b	5.8^c	6.3^c	6.8^c

Table 2: a: HCNE/v015 release note; b: Berta et al. (2010) ; c: Griffin et al. (2010) and Nguyen et al. (2010)

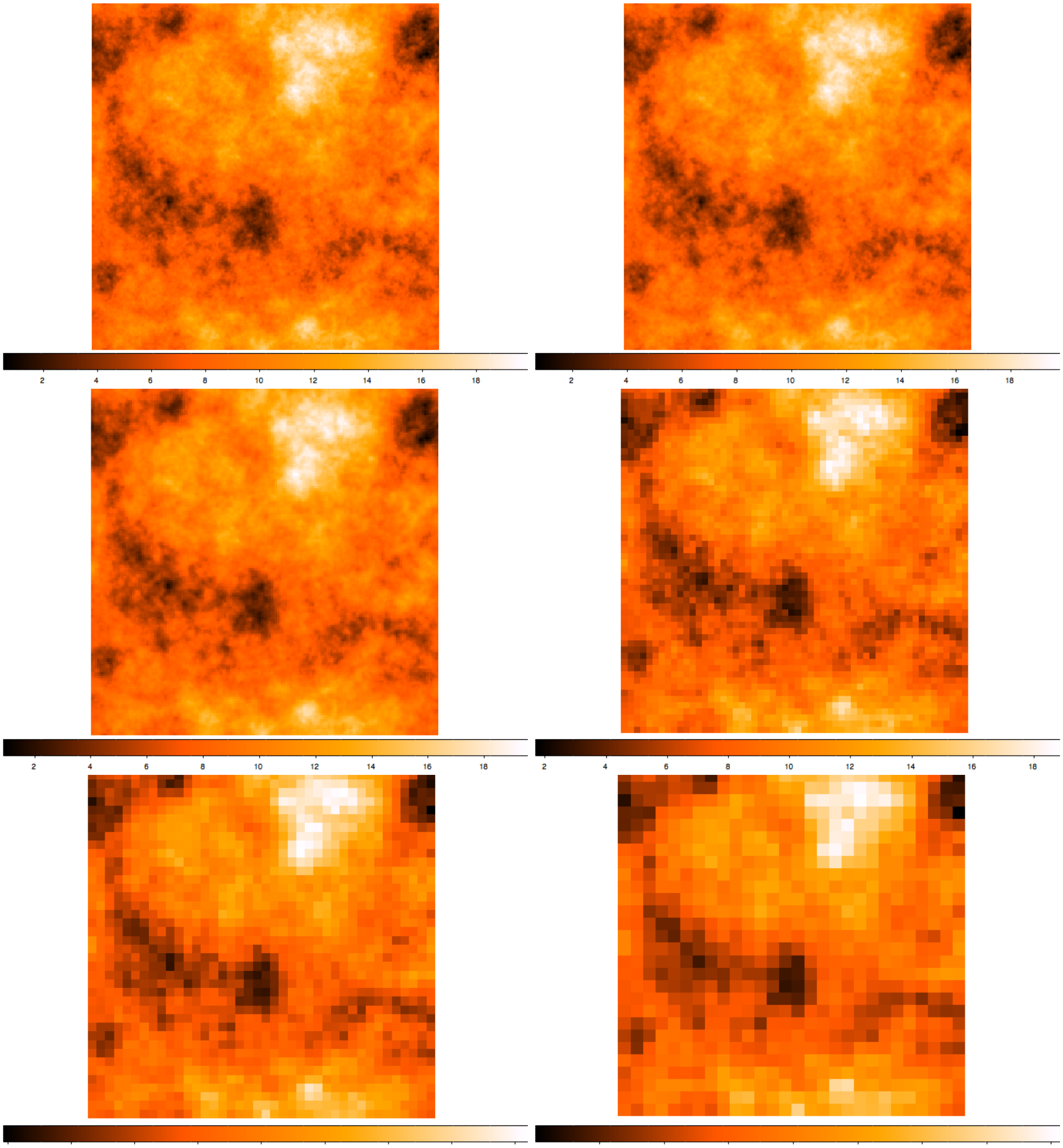

Figure 2: The simulated cirrus structure as seen at the PACS and SPIRE bands. The images correspond to the 70, 100, 160, 250, 350 and 500 μm photometric bands from left to right and top to bottom

References

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Kiss, Cs., Vavrek, R., Herschel Confusion Noise Estimator update patch v015, HERSCHEL-HSC-MEM-0925 (release note)