MOPEX Coverage Map

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One of the ancillary products produced with a mosaic image by MOPEX is the corresponding coverage map. The mosaic coverage map is a simple sum of the coverage maps of the interpolated images. In general, the definition of the coverage map of an interpolated image is that the pixel value in the coverage map represents the amount of overlap of the output interpolated pixel with the good pixels of the input image. E.g. if the output pixel projected onto the input image frame overlaps only valid (non-NaN) pixels the coverage should be 1. If any part of the output pixel has an overlap with bad pixels the coverage is less than 1 by the amount of the overlap with the bad pixels.

 MOPEX has several interpolation methods. The first two methods are supposed to produce the same results in the default configuration (Drizzle factor = 1, see Mosaicker User's Guide). An astute user, however, may ask, how come, when the interpolation is done using method 2 the pixels values in the coverage map for the same mosaic will be mostly integers, such 10, 8, etc. However, using method 1 the coverage map have pixel values are very close to, but not exact integers, such as 10.034, 8.993, etc.

The answer to this question is that even though both methods produce the same answer in principle, the differences in implementation lead to slightly different interpretation of the coverage maps and slightly different results.

Both methods 1 and 2 employ the area overlap interpolation technique. The value O_j of an output interpolated pixel j is equal to the weighted average of the input pixels I_i overlapping the output pixel. It is weighted with the relative overlap areas:

$$O_j = \sum_i \frac{a_{ji}}{A_j} I_i \ , \text{where} \qquad A_j = \sum_i a_{ji}$$

Here a_{ij} is the area of the overlap of output pixel j with input pixel i. Each interpolated image is accompanied with the coverage map, as mentioned above. The coverage Cj is equal to the properly rescaled total area Aj. However, this area for the two methods is measured in different coordinate systems. This is where the differences between the two methods arise.

Method 1. For this method the output pixels are projected onto the input frame (see Figure 1). The area covered by the output pixel is measured in terms of the input pixels. It is normalized by the ratio of output pixel area to the nominal input pixel area. The nominal pixel size *cdelt1* and *cdelt2* are derived from the *cd*-matrix without taking into account the distortion:

$$cdelt1 = cos(crota2) * cd11 + sin(crota2) * cd21$$

$$cdelt2 = -sin(crota2) * cd12 + cos(crota2) * cd22$$

$$crota2 = arctan(cd12/cd22)$$

If the output pixels have size *CDELT1* and *CDELT2* the total area *Aj* is normalized as:

$$\tilde{A}_j = \frac{cdelt1 \cdot cdelt2}{CDELT1 \cdot CDELT2} A_j$$

The coverage $Cj = \tilde{A}_j$. In the absence of bad pixels the coverage is the measure of the ratio of the nominal input pixel area to the input pixel area at a particular detector array location. Due to the distortion in the input image this ratio varies across the detector array. As a result the coverage map has pixels with the values that are slightly different from 1 (see Figure 2*a*).
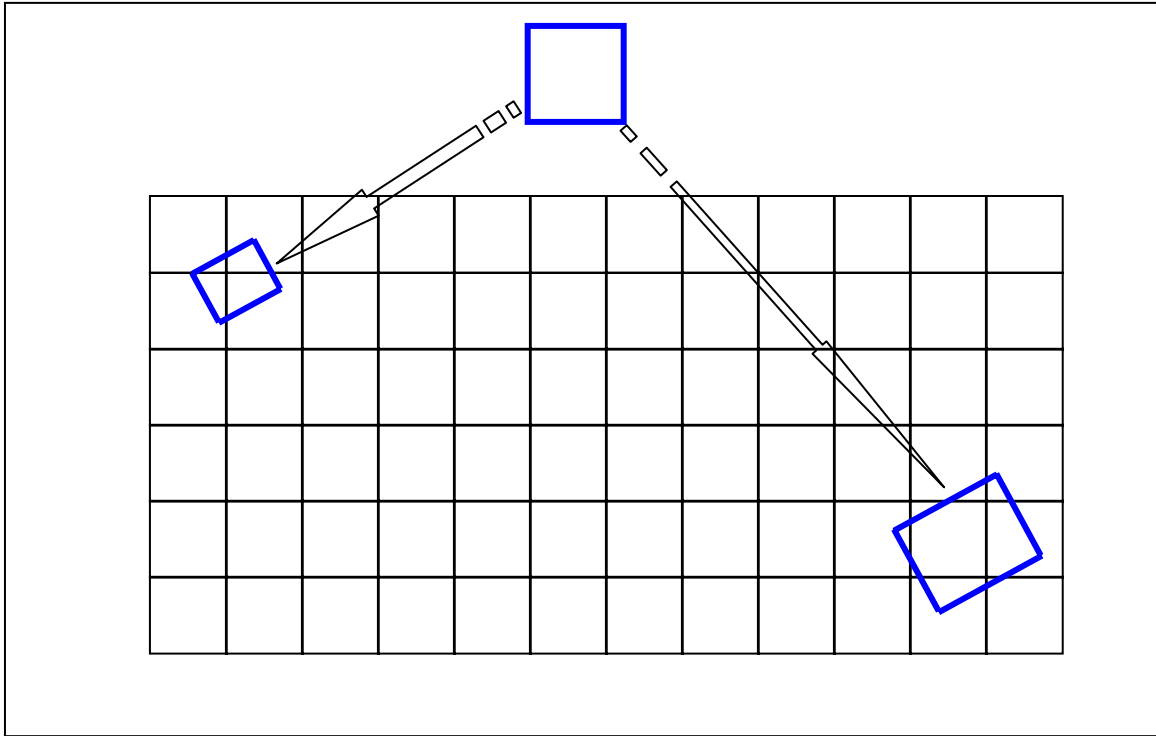

Figure 1. The output pixel (blue) is projected onto the input frame (black). Because of the distortions the input coordinate system is curvilinear, and the area of the projection measured in the native coordinate system of the input frame depends on the projection position in the input image.

There is one possible application of this kind of coverage map. For Spitzer the bcd's and the interpolated images are in the units of surface brightness (MJy/Sr). The product of the interpolated image and the coverage image is the image that represents the amount of flux observed by the interpolated pixels.

Method 2. For this method the input pixels are projected onto the output frame. The overlap area is computed in the coordinate system of the output frame. The area of the output pixel by definition is equal to unity. Consequently, in the case of no bad input pixels the coverage map is equal to 1 (see Figure 2*b*).
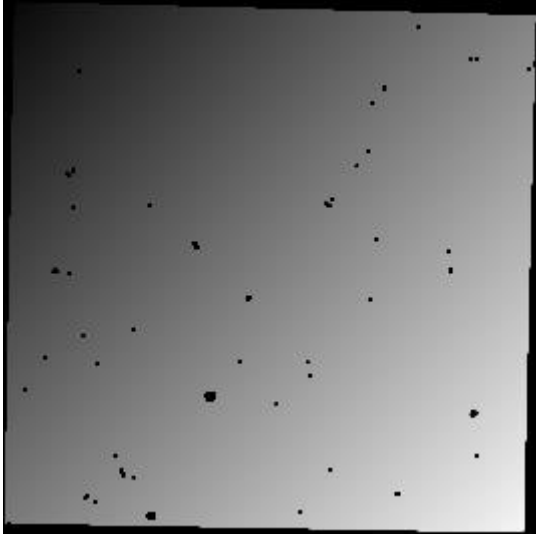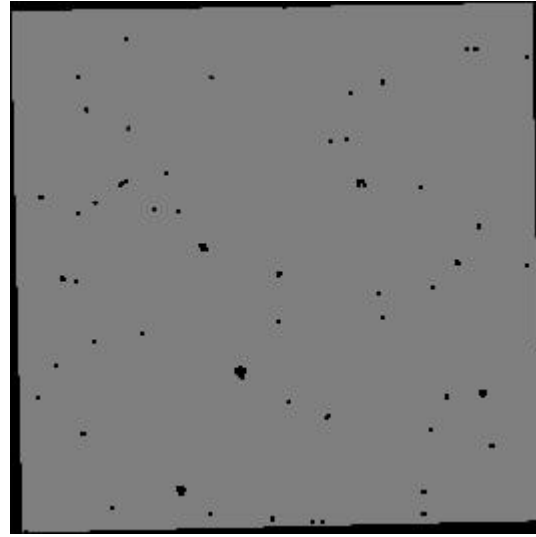
a.   *b.*

Figure 2 The coverage maps for a typical IRAC1 interpolated images: *a*. is produced by Method 1; *b*. is produced by Method 2. The holes correspond to the bad pixels in the input bcd image. The pixel value display range is set to [0.98-1.02]. The pixel values in *a*. are increasing monotonously from the upper left corner to the bottom right corner.

References:

Mosaicker User's Guide (Spitzer_mosaicker.pdf)