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UPDATES OF IRC IMAGING TOOLKIT AND DATA ARCHIVE

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ABSTRACT

We have been working on data processing and calibration of AKARI/IRC images from pointed observations. As of September 2014, a data package for each pointing only contains raw data and quick-look data, so that users have to process them using the toolkit by themselves. We plan to change this situation and to provide science-ready data sets, which are easy-to-use for non-AKARI experts. For Phase 1&2, we have updated dark and flat calibrations, and also the toolkit itself to produce images more reliable and easier to use. A new data package includes fully calibrated images with WCS information. We released it for about 4000 pointings at the end of March 2015.

Key words: methods: data analysis – techniques: image processing – infrared: general

1. DATA PROCESSING & ARCHIVE

For Phase 1&2, when all the three channels of IRC (i.e. NIR, MIR-S, and -L) used for observations, we selected pointings with AOT = IRC0x (x = 0, 2, 3, 4, 5), which includes spectroscopic observations and parallel IRC observations with main target(s) in the FIS field of view. After this AOT selection, pointings with no valid data were excluded. Data sets taken during the PV2 phase (after Phase 2 and before Phase 3) were also excluded, since detector conditions changed rapidly and additional treatments may be needed. As a result, we have 3909 pointings in total that are processed and archived.

All the data packages, the toolkit, and related documents are released on March 31, 2015, and available online.[1] A data package for each pointed observation contains new dark frames for MIR (see §2.1), a readme file, a process log, and calibrated and stacked images. Egusa et al. (2016) describe more detail of the data processing and quality of released data sets.

[1]http://www.ir.isas.jaxa.jp/AKARI/Archive/.

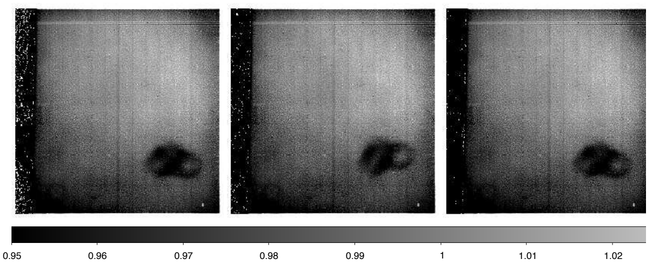

Figure 1. New flat frames for S9W.

2. NEW FEATURES OF THE TOOLKIT

The following subsections describe major updates in the latest version (Ver. 20150331) of the IRC imaging toolkit, in the order of the pipeline processing. In addition, the toolkit has been revised to create a process log, in which computer environments, parameters for the toolkit, etc. are recorded.

2.1. Neighbor Dark

For MIR-S and -L long exposure frames, we have created new dark frames called “neighbor dark” by combining pre-dark frames taken in ±5 neighbor pointings. The neighbor dark should better calibrate temporal variation (especially increasing warm and hot pixels in MIR-L)

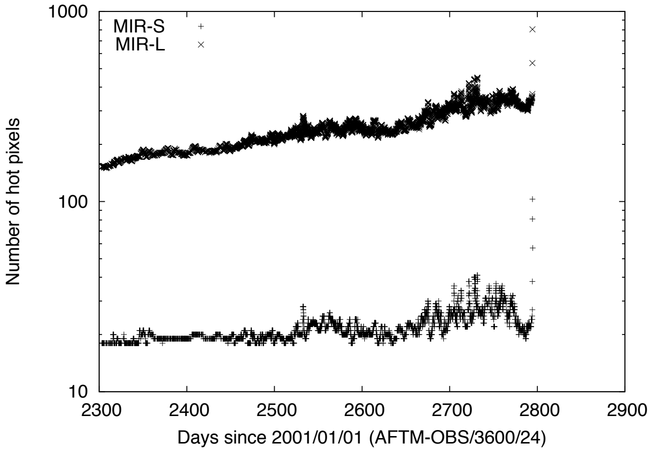

Figure 2. The number of hot pixels for MIR-S (+) and -L (x) against time.

than super dark and provide better S/N than self dark. The new dark frames are included in the archival data package for each pointing, so that users can reproduce the results by themselves if needed.

2.2. NEW MIR-S FLAT

Murata et al. (2013) reported temporal variation of the MIR-S flat pattern so-called "soramame" and claimed five typical patterns and corresponding periods. However, data in the second period were severely affected by the earthshine light (see §3.2) so that it was difficult to create a flat frame only from this period. Since the difference between second and third patterns was small, we have decided to treat the second and third period as a single period. Furthermore, the first period was so short that created flat frames were relatively noisy and not reliable.

We have thus determined to provide three new flat frames for each MIR-S filter in the toolkit. Figure 1 shows them for S9W.

We have also found a fainter but similar pattern in NIR flat frames. Since the number of frames is smaller and the temporal shape variation is less remarkable, only one flat frame for the entire period with "soramame" has been created for each NIR filter.

2.3. Hot Pixel Masking

We have defined a pixel with count in the neighbor dark frame exceeding 500 to be a hot pixel. The number of hot pixels increased with time especially for MIR-L as shown in Figure 2. Masking such pixels should increase the success rate of the position alignment and stacking.

If necessary, users can change the above definition of hot pixels or even skip the masking in the toolkit.

2.4. Shift Value Statistics

Before stacking, a single pixel is divided into 2×2 pixels. Users can turn off this option if preferred. The toolkit then calculates shift values in (x, y, angle) with respect to the first frame for each filter. We have calculated mean and standard deviation (σ) of them in order to identify false results of shift value calculations which are mostly due to the small number of sources in the field of view. This statistics calculation for shift in x- and y-direction has been performed using data from each dithering cycle for AOT = IRC02 and IRC03 and using all the data for AOT = IRC05. The calculation for rotation angle has been done using all the data even for AOT = IRC02 and IRC03, since the difference between the dithering cycles was found to be small.

The mean and σ for each observing setup have been stored in the toolkit, and if calculated shift values deviates from the mean by 10σ or more, the corresponding frame will be excluded from stacking.

2.5. WCS Registration

For MIR-S and MIR-L frames, WCS matching is now done using WISE (W3) catalog[2] instead of 2MASS (K) catalog[3], which is still used for NIR frames. This update should increase the success rate of WCS registration for the MIR channel.

An additional check for the direction of the North on the image has been incorporated. If the new North direction is significantly different from the corresponding value in the FITS header, this WCS matching is rejected. This update should decrease the rate of false WCS registration.

2.6. Flux Calibration

A new module to apply conversion factors for point sources provided by Tanabé et al. (2008) to stacked images has been added to the toolkit. For several pointings, we have confirmed that these factors are also applicable to extended objects (e.g. Egusa et al., 2013).

[2] Wide-field Infrared Survey Explorer is a joint project of the University of California, Los Angeles, and the Jet Propulsion Laboratory/California Institute of Technology, funded by the National Aeronautics and Space Administration.

[3] Two Micron All Sky Survey is a joint project of the University of Massachusetts and the Infrared Processing and Analysis Center/California Institute of Technology, funded by the National Aeronautics and Space Administration and the National Science Foundation.

3. REMAINING ISSUES

In the following subsections, some of issues not fully calibrated in the released data sets are described.

3.1. Memory Effect

If one or more extremely bright objects are in the field of view, the sensitivity of corresponding pixels decreases by a few percent for several hours, so that data taken in the successive pointings are affected. This effect called "memory effect" and especially remarkable in MIR-S data.

For some cases, we have confirmed that applying the saturation mask from the previous pointing, which observed bright objects, to the affected data can successfully mask the affected pixels and create more reliable stacked images. Tasks to perform this copying and adding the masks are included in the toolkit. We provide a warning for this effect in the released data sets.

3.2. Earthshine Light

In some pointings, especially observing targets at high ecliptic latitude during summer, the background level changes significantly due to a stray light of the earthshine.

The toolkit already contains modules to create a template for the earthshine light and to subtract it from affected frames, which have been confirmed to work successfully for several pointings (e.g. Egusa et al., 2013).

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