# 2MASS PRODUCTION PROCESSING SYSTEM

## DARKS

## Subsystem Design Specification

**Version 1.6**

**26 August, 1998**

Infrared Processing and Analysis Center
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## 1. Overview

The DARKS subsystem generates the darks, responsivity images, and masks for each band for a given date-hemisphere (i.e., observation date and observatory).

### 1.1 Requirements

The requirements on the DARKS subsystem are as follows.

A.) Determine whether the observation night being processed included
  i.) dark sequence(s)
  ii.) twilight flat sequence(s).

B.) If dark sequences were taken, compute dark images and mask information from them (evening or morning or both, as available; if both, compare morning and evening results, then average them if differences are within limits, unless only morning or evening results have been selected); test the medians of each quadrant of each dark frame against the corresponding scan median and reject dark sequences with too many out-of-limits medians or standard deviations of the quadrant medians over the scan.

C.) If twilight flat sequences were taken, then compute each band's responsivity image, intercept, and mask from these sequences (evening or morning or both, as available; if both, compare morning and evening results, then average them if differences are within limits, unless only morning or evening results have been selected).

D.) Compare the current results, if any, with the "canonical" MRD files (masks, responsivities, and darks; if any), report significant discrepancies, and pass on either the previous canonical files or the weighted averaging of the latter with the current results for the processing of the observation night; provide input to the QUALITY subsystem for problem identification; write current results to a history data base for use in offline trend analysis.

### 1.2 Applicable Documents

The following documents are relevant to the DARKS subsystem.

A.) The 2MASS Level 1 Requirements Document
B.) The 2MAPPS Functional Requirements Document
C.) The 2MAPPS Functional Design Document
D.) The following Software Interface Specifications (SIS)
  DRK01, DRK02, DRK03, DRK04, DRK05,DRK06, DFL01, TAP01

### 1.3 Version History

1.3.1.0 Version 1.0 970919, initial version

1.3.1.1 Version 1.1 970929: changed origin of "canonical" MRD files from darks history directory for hemisphere to darks history directory for most recent previous observation date for hemisphere; in other words, the canonical MRD files for a given date are the MRD files actually used to process the most recent previous observation date, even if those were obtained from dark/flat sequences taken on that date; this allows closer tracking of slowly varying hardware parameters, while removing some "human-in-the-loop" safety; the latter is to be augmented by additional procedures in the QUALITY monitoring activity.

1.3.1.2 Version 1.2 980130: changed default of `UseMsk0` from `6*F` to `6*T` (i.e., by default, masks computed by DARKS will *not* be used for downstream processing; the canonical masks will be used); changed `MaxSD` from dimension (3) to dimension (3,2) to separate read types; set Read1 rejection and new-old/morn-eve dark-difference thresholds very high to disable them (`MaxSD`, `MaxDfMn`, `MaxDfSD`, `MaxMEMn`, `MaxMESD`); added option to use evening or morning darks/responsivities only (`EDOnly`, `EROnly`, `MDOnly`, `MROnly`; used only when both evening and morning sequences are available; default: use morning only); added option to write responsivity sigma as FITS image (`WRSImg`; default: true); added quadrant-median tests for dark rejection; added dark-median table-file output option (`DmpDFM`; default: true).

1.3.1.3 Version 1.3 980324: added "SatDNs" image of soft-saturation values (replaces a single value per pixel as soft-saturation limit); added band-coupling to acceptance of darks and resps, i.e., no band's new responsivity may be accepted unless all bands' are, and similarly for Read1 darks and Read2-Read1 darks (the two read types remain uncoupled); short-circuited all new-old and morning-evening rejection thresholds except for responsivity changes, loosened those.

1.3.1.4 Version 1.4 980428: modified defaults, mostly thresholds to permit flats to be accepted.

1.3.1.5 Version 1.5 980724: added `Reject` option for responsivities.

1.3.1.6 Version 1.6 980826: added `MinMed` parameter for responsivity calculation.

### 1.4 Liens

There are no liens at this time.

## 2. Input

The following files and command-line parameters are input to the DARKS subsystem.

### 2.1 Canonical MRD Files

The canonical MRD files consist of 15 files per hemisphere with names and descriptions as follows.

| | | |
|---|---|---|
| jmask.fits | : | mask for J-band Read2-Read1 frames |
| jmask_1.fits | : | mask for J-band Read1 frames |
| hmask.fits | : | mask for H-band Read2-Read1 frames |
| hmask_1.fits | : | mask for H-band Read1 frames |
| kmask.fits | : | mask for Ks-band Read2-Read1 frames |
| kmask_1.fits | : | mask for Ks-band Read1 frames |
| jdark.fits | : | dark for J-band Read2-Read1 frames |
| jdark_1.fits | : | dark for J-band Read1 frames |
| hdark.fits | : | dark for H-band Read2-Read1 frames |
| hdark_1.fits | : | dark for H-band Read1 frames |
| kdark.fits | : | dark for Ks-band Read2-Read1 frames |
| kdark_1.fits | : | dark for Ks-band Read1 frames |
| jresp.fits | : | responsivity for J-band Read1 and Read2-Read1 frames |
| hresp.fits | : | responsivity for H-band Read1 and Read2-Read1 frames |
| kresp.fits | : | responsivity for Ks-band Read1 and Read2-Read1 frames |

These files are obtained as follows, where reference to "previous" nights implies the most recent nights in observation order. The dark and mask files are copied from the previous night's "darkhist/date" directory (the "darkhist" directory is a directory for historical data peculiar to the DARKS subsystem; underneath it are "date" directories containing the MRD files for each observation date processed) to the darks directory (under the date-hemisphere directory) prior to executing the DARKS main program. The resp files are obtained by averaging the `NPrev` (see section 2.5) previous nights' files, using only nights for which a full set of resp files were found to be acceptable. If these files are not available (e.g., at the beginning of the survey), DARKS will continue to execute without them, but warning messages will be written stating that attempts to access these files failed.

### 2.2 Command-Line Parameters

Three command-line parameters (see SIS DRK04) are specified on the DARKS command line; these are the names of the NAMELIST files for DARKS and RDFRAME and the name of the "tls" file (see SIS TAP01).

### 2.3 The “tls” File

The “tls” file for the date-hemisphere being processed (see SIS TAP01) is generated by the TAPELOAD subsystem and is read directly from its resident directory. It contains information on the observation date, the day number (needed by RDFRAME; see the Obs/IPAC Interface Document), the location of the appropriate raw data, and the scan numbers for dark and twilight flat sequences. DARKS reads this file in order to obtain the directory information needed to open the appropriate scan files.

### 2.4 NAMELIST Input

DARKS reads the NAMELIST file whose name is passed to it on its command line. The name of the NAMELIST is DARKIN. The parameters defined in the NAMELIST are as follows.

| Name | Description | Dim | Type | Units | Default |
|---|---|---|---|---|---|
| AndMsk | If AndMsk(I,J) = T, then for band I and read-type J, the new and old masks will be logically ANDed | 3,2 | L | - | 6*T |
| DarFlg | Dark-sequence flag in tape header | | C*3 | - | ‘dar’ |
| DmpDFM | If T, dark frame/quadrant medians will be written to table files | | L | - | F |
| DmpFITS | If T, corresponding raw frames will be dumped as FITS files[3] | 3,2,3 | L | - | 18*F |
| DmPix | Up to ten pixel coordinates to dump to a table file from every dark-subtracted frame read in for use in the responsivity calculation | 2,10 | I*4 | - | 20*0 |
| DRLim | Maximum number of pixels failing the MaxRDif test for a responsivity image to be accepted [1] | 3,2 | I*4 | - | 6*500 |
| EDOnly | If T, evening darks only will be used if available | | L | - | F |
| EROnly | If T, evening resps only will be used if available | | L | - | F |
| ErrHnd | IEEE error handle installation flags for underflow, overflow, invalid operand, and division by zero; if T, handler will be installed | 4 | L | - | 4*T |
| FltFlg | Flat-sequence flag in tape header | | C*3 | - | ‘flt’ |
| IErrMx | Maximum RDFRAME error code to continue execution | | I*4 | - | 4 |
| Max1Sat | Maximum number of saturated pixels in Read1 to accept Read2-Read1 frame for use in responsivity computation (one per band) | 3 | I*4 | - | 3*200 |

| Name | Description | Dim | Type | Units | Default |
|---|---|---|---|---|---|
| Max2Sat | Maximum number of saturated pixels in Read2 to accept Read2-Read1 frame for use in responsivity computation (one per band) | 3 | I*4 | - | 3*2000 |
| MaxDfMn | Maximum absolute mean of new-old pixel values for J/H/K responsivity, J/H/K Read1 darks, and J/H/K Read2-Read1 darks, respectively [2] | 9,2 | R*4 | -/DN | 3*0.003, 3*9999, 3*9999, 9*99999 |
| MaxDfSD | Maximum sigma value of new-old pixel values for J/H/K responsivity, J/H/K Read1 darks, and J/H/K Read2-Read1 darks, respectively [2] | 9,2 | R*4 | -/DN | 3*0.005, 3*9999, 3*9999, 9*99999 |
| MaxMed | Maximum permitted dark-subtracted frame median to keep in stack for responsivity calculation; one/band | 3 | R*4 | DN | 3*25000 |
| MaxMEMn | Maximum absolute mean of morn-eve pixel values for J/H/K responsivity, J/H/K Read1 darks, and J/H/K Read2-Read1 darks, respectively [2] | 9,2 | R*4 | -/DN | 3*0.003, 3*9999, 3*10.0, 9*99999 |
| MaxMESD | Maximum sigma value of morn-eve pixel values for J/H/K responsivity, J/H/K Read1 darks, and J/H/K Read2-Read1 darks, respectively [2] | 9,2 | R*4 | -/DN | 3*0.005, 3*9999, 3*25.0, 9*99999 |
| MaxPass | Maximum number of linear least-square passes per pixel allowed in the responsivity calculation | | I*4 | - | 10 |
| MaxRDif | Maximum absolute morning-evening and new-canonical responsivity difference for a pixel not to be included in sum for DRLim test (see above) [1] | 3,2 | R*4 | - | 6*0.05 |
| MaxSD | Maximum sigma value for a pixel’s dark average for each band; pixel is masked if exceeded | 3,2 | R*4 | DN | 3*9999, 3*25.0 |
| MDOnly | If T, morning darks only will be used if available | | L | - | T |
| MinMed | Minimum permitted dark-subtracted frame median to keep in stack for responsivity calculation; one/band | 3 | R*4 | DN | 3*4000 |
| MinFrac | Minimum fraction of raw pixel values to retain in final least-square pass | | R*4 | - | 0.4 |
| MinFrms | Minimum number of usable frames to proceed with responsivity computation (one per band) | 3 | I*4 | - | 3*30 |
| MROnly | If T, morning resps only will be used if available | | L | - | T |

| Name | Description | Dim | Type | Units | Default |
|---|---|---|---|---|---|
| MskNam | Name of a file of band/pixel-coordinates to be forced off in the masks for both read types; if the default is overridden, a file of that name will be opened in the working directory and read to the end; each line is to have a (I2,2I4) format for band (1-3 for J-K) and pixel (column,row) number | | C*80 | - | '<noname>' |
| MxDQMd | Maximum accepted distance of a frame-quadrant median from it corresponding scan median | | R*4 | DN | 5.0 |
| MxFrDQ | Maximum fraction of frames that may violate MxDQMd and still accept the dark sequence | | R*4 | - | 0.1 |
| MxSgDQ | Maximum standard deviation of the frame-quadrant median for acceptance of a dark sequence | | R*4 | DN | 8.0 |
| NamWrt | NAMELIST echo flag; if T, this NAMELIST will be written to stdout after input | | L | - | F |
| Reject | If T, responsivities will be rejected undonditionally | | L | - | F |
| RngMin | Minimum range in frame median to proceed with responsivity computa-tion (one per band) | 3 | R*4 | - | 2*10000, 5000 |
| RspMax | Maximum responsivity value in J/H/K; if exceeded, pixel is turned off in the corresponding masks | 3 | R*4 | - | 3*1.5 |
| RspMin | Minimum responsivity value in J/H/K; if less, pixel is turned off in the corresponding masks | 3 | R*4 | - | 3*0.5 |
| SigRej | Sigma rejection level for linear least-square passes after the first | | R*4 | DN | 2.0 |
| TrmFrac | Fraction of total number of dark values for a pixel to be trimmed from each end of sorted array before averaging | | R*4 | - | 0.25 |
| UseMsk0 | If UseMsk0(I,J) = T, then the old mask for band I and read-type J will be used despite any test results | 3,2 | L | - | 6*T |
| UseNMsk | If UseNMsk(I,J) = T, then the new mask for band I and read-type J will be used despite any test results | 3,2 | L | - | 6*F |
| WrDSig | If T, images if the standard devi-ations about the trimmed-average darks will be written to disk | | L | - | T |
| WrtDif | If WrtDif(N) = T, morning-evening difference images will be written for darks and responsivities (N=1) and similarly for new-canonical (N=2) as available | | L | - | F,T |

| Name | Description | Dim | Type | Units | Default |
|---|---|---|---|---|---|
| WRSImg | If WRSImg(1) = T, the standard deviation about the linear-fit responsivity will be written in FITS format; if WRSImg(2) = T, the standard deviation about the mean responsivity in the moving-window average will be written in FITS format | 2 | L | - | F,T |

Notes

[1] The first index in the (3,2) dimension is band (J, H, K), and the second index has the value 1 for morning-evening differences and 2 for new-canonical differences.

[2] The second index in the (9,2) dimension is a severity index; the first value causes warning messages to be displayed if exceeded, the second causes DARKS to return an error code of 4 after finishing its computations, which halts the pipeline.

[3] The indexes are (Band,SeqType,ReadType), where SeqType = 1 for dark sequences, 2 for twilight flat sequences; ReadType = 1 for Read1, 2 for Read2, 3 for Read2-Read1. File names are the same as for raw frames generated by PIXCAL/DFLAT, i.e., BSSS####.fits, where B = j, h, or k; SSS = scan number; #### = frame number; ReadType = 1 and 2 have "_1" and "_2" inserted in the name preceding the period. Example: DmpFITS(2,2,3) = T will cause the Read2-Read1 frames for twilight-flat scans in h band to be dumped as FITS files.

### 2.5 GETMASK and GETCAN Output

GETMASK ("Get mask files") and GETCAN ("Get Canonicals") are utility programs executed by the DARKS wrapper script prior to the execution of DARKS itself. Both read the file maskdat in the darkhist directory to find out the boundaries of the stable-hardware periods. GETMASKprovides the name of the subdirectory containing the masks for the period corresponding to the observation date.GETCAN searches under the darkhist directory to find the NPrev (default: 5) most recent previous nights in observation order that contain a full set of accepted new responsivities. This is done so that these can be averaged and used as canonical responsivities for the night being processed. `NPrev` is specified on the GETCAN command line after the name of the darkhist directory and the observation date. GETCAN will not cross hardware-period boundaries and may be made to look forward or backward or both (the last only if a hardware-period boundary was encountered). Normally the search is backwards, i.e., `NPrev` > 0. If `NPrev` < 0, the search will be forward. In either case, if a fourth command-line parameter "both" is given, encountering a hardware-period boundary will cause both directions to be used.

## 3. Processing

The DARKS subsystem consists of a FORTRAN program that employs the RDFRAME subroutine. The latter is maintained as part of the TAPELOAD subsystem and is also used by the DFLAT subsystem. A description of RDFRAME is given in an Appendix in the PIXCAL/DFLAT SDS.

The DARKS subsystem is invoked by a "wrapper script" named darks.csh (see SIS DRK04) that handles certain setup operations, namely:

A.) sets up the canonical MRD files (see below) from the darkhist directories for the most recent previous observation dates and hemisphere;

B.) creates the directory underneath the darkhist directory that will receive the MRD files computed in the current run; this new subdirectory will have the observation date as its name;

C.) copies the NAMELIST files for DARKS and RDFRAME to the darks directory for the observation date and hemisphere;

D.) invokes the DARKS program with the three required command-line parameters (names of the DARKS NAMELIST file, the RDFRAME NAMELIST file, and the "tls" file);

E.) after execution of the DARKS program, copies the MRD files (some or all of which may have been overwritten by the DARKS program) to the date-hemisphere directory, from where the PCP subsystem will access them for each scan; the intercept files, if any, are also copied (these are a by-product of the twilight flat processing; see below); these files are also copied to the darkhist/date directory, from where they will serve as canonicals for the next observation night for the hemisphere.

The canonical MRD files are the masks, responsivity images, and darks accepted for processing the most recent previous observation night for the hemisphere. These files are computed and analyzed on a nightly basis during the survey.

It is expected that minor night-peculiar variations in the MRD files will take place, and when they do, the night-peculiar values will be considered preferable to the canonical values. DARKS must therefore compare the night's values to the canonical ones and decide whether to use the new ones. For any new file that is to be used, DARKS will overwrite the copy of the corresponding canonical file in the darks directory (*not* in the darkhist directory). Whatever is in the darks directory after DARKS terminates will be copied to the darkhist/date directory for the hemisphere and used in the subsequent processing of all of the night's survey and calibration scans, unless errors too serious to continue are discovered by DARKS.

Independently of whether the copied canonical MRD files are overwritten, the new MRD files will always be written to the date subdirectory of the darkhist directory (for the hemisphere being processed, as always; this qualification will be understood implicitly in the remainder of this section).

The only exceptions to this are when no twilight-flat sequences are available, or when no dark sequences are available, or both. When both morning and evening twilight flat sequences are available, the frames in all evening sequences will be analyzed as a single sample, the frames in all morning sequences will be analyzed as a single sample, the differences between evening and morning sample results will be analyzed, and if the differences are within specified bounds, the two sets of results will be averaged. If the differences are out of limits, processing of the observation night will halt with an error code of 4. The same processing rules will apply to dark sequences.

The comparison between morning and evening results will consist of frame subtraction followed by an averaging over all unmasked pixels. Corresponding frames will be processed in this way, e.g., the morning responsivity image for band J will be subtracted from the evening responsivity for band J. The unmasked pixels will then be averaged in the difference image, and the standard deviation about this average will be computed. The absolute value of the mean and the standard deviation must both be smaller than specified limits (see `MaxMEMn` and `MaxMESD` in section 2.4), or else the processing of the date-hemisphere will be terminated with an error code of 4. This test is applied to all dark and responsivity images computable from evening and morning sequences. The difference images will be written to the darkhist observation-date directory if requested (see `WrtDif` in section 2.4).

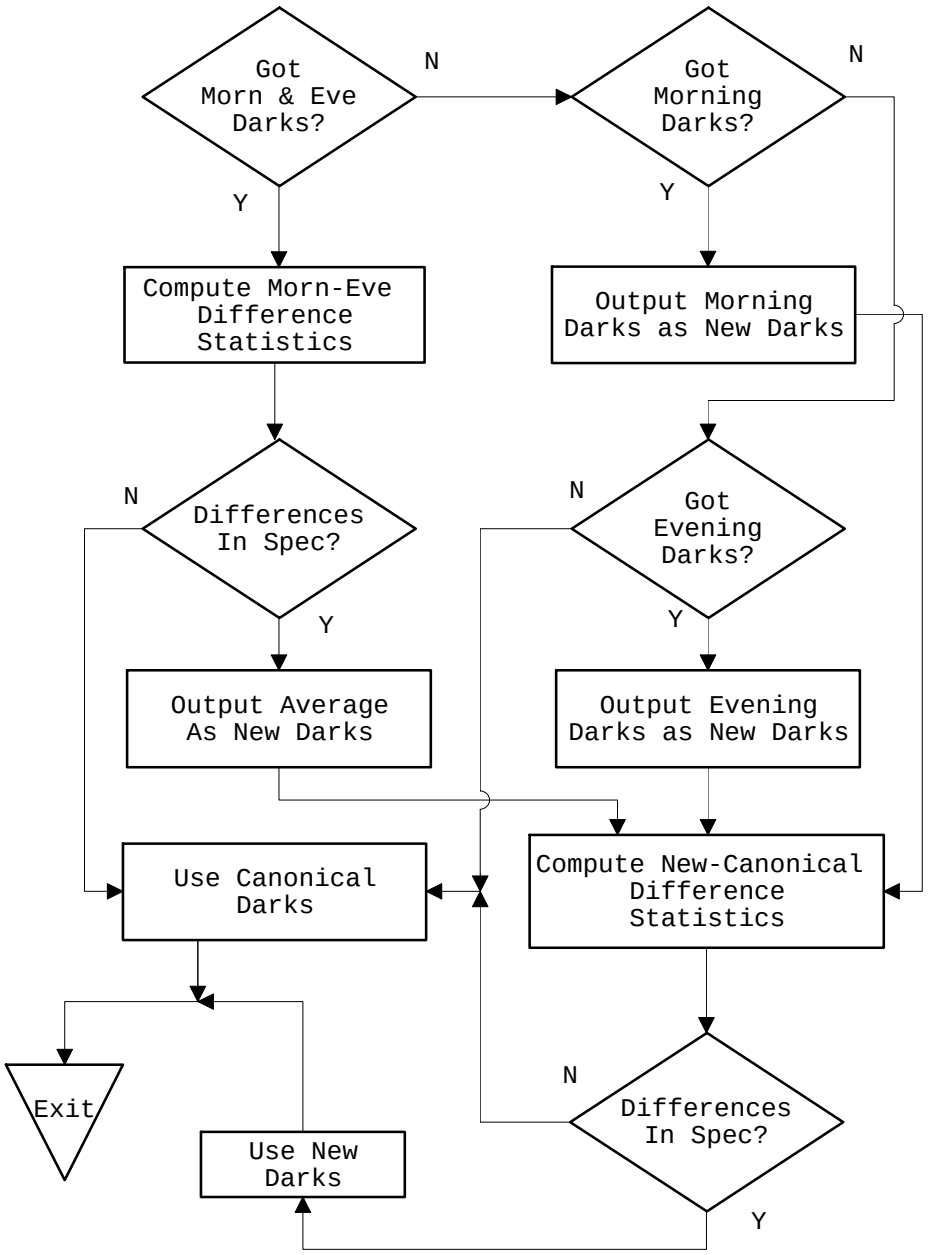
Figure 1 illustrates the decision flow for processing evening, morning, and canonical darks. The same logic is used for responsivities (all bands and both dark read types). If it was possible to compute darks from evening and morning scans, then comparison of the two sets of results is undertaken; for a given band and read type, if the two images are within spec (i.e., if the difference statistics are less than the thresholds), then the two images are averaged and output as the "new" dark; if the differences are too large, neither image is used, and the canonical dark is used for the night's processing. If only a morning or only an evening dark was available, whichever was available is output as the "new" dark. If a new dark was not available, the canonical dark is used.

If a "new" dark was output for the given band and read type, then it is compared to the corresponding canonical dark by computing the same difference statistics. If these results are within threshold, then the "new" dark is used instead of the canonical dark for the night's processing.

TBD: an "all-or-nothing" option may be implemented that requires all "new" dark images to be within spec for any to be used, and similarly for responsivity images.

The remainder of this section will be concerned with how the new masks, responsivities, and darks are computed, if they are. DARKS reads its NAMELIST file and initializes itself. It opens the "tls" file and reads it to obtain the observation date, day number, and the names of the J, H, and Ks raw-data directories. It also obtains from this file a list of scan numbers for all dark and twilight flat sequences. For each band, a mask image is initialized by setting each pixel's value to 1.0, which indicates "on".

Figure 1. Processing Evening, Morning, & Canonical Darks



### 3.1 Darks Computation

DARKS processes dark sequences first if they are available. It loops over band, doing the same tasks for each band, so only single-band processing will be described.

For each "scan", RDFRAME must be initialized, used for raw frame access, and terminated. Initializing RDFRAME consists of passing it the observation date, day number, "scan" number, band identifier, and RDFRAME NAMELIST file name, along with an initialization code. If multiple dark sequences exist (i.e., multiple evening sequences or multiple morning sequences, without mixing of the two groups), their raw data frames are treated as belonging to one large sequence, so each access of a raw data frame by DARKS consists of checking whether the end of one "scan" has been reached and whether another "scan" exists; if both conditions are true, then RDFRAME is terminated and re-initialized for the next "scan", and then raw frame access by DARKS continues.

The dark value for a given pixel is obtained by a trimmed-average calculation. The values for that pixel over the complete set of raw frames in the dark sequence(s) are sorted, a specified fraction (see `TrmFrac` in section 2.4) is trimmed from the high and low ends of the sorted array, and the remaining values are averaged. The standard deviations about the means are also computed for the same trimmed set of samples. Pixels whose standard deviations are greater than a threshold (see `MaxSD` in section 2.4) are turned off in the mask.

The canonical dark values are subtracted from the new values, and the mean and standard deviation of the difference is computed, where the averaging is over all pixels that are "on" in both the new mask and the canonical mask. If either the absolute mean or the standard deviation is greater than its respective high-severity threshold (see `MaxDfMn` and `MaxDfSD` in section 2.4, respectively), then the processing of the observation night is halted with an error code of 4, although DARKS itself does not terminate until after its other tasks have been completed. If only the low-severity threshold is violated, warning messages are issued, but the observation night's processing is not terminated, and an error code of 2 is returned to EXEC. The mean and standard deviation are written to the QUALITY output file (see SIS DRK05).

One last test is performed to verify the acceptability of the new darks for each band: the "quadrant-median test". This consists of computing the median *M(q,f)* in each array quadrant *q* in each raw Read2-Read1 frame *f* and the scan-median of these quantities, *M(q)*. Then for each quadrant, the absolute value of the difference between *M(q,f)* and *M(q)* is computed for each frame, and the number of times this is greater than `MxDQMd` is counted; if this is greater than the product of `MxFrDQ` and the number of frames, then the new Read1 and Read2-Read1 darks are rejected for that band. The standard deviation of *M(f,q)* over the scan is also computed; if this is larger than `MxSgDQ` for any quadrant, then the new Read1 and Read2-Read1 darks are rejected for that band. The frame medians and *M(q,f)* values are written to the DRK06 file.

### 3.2 Responsivities Computation

If acceptable darks were obtained as described in the previous subsection, they are used in the computation of responsivities, and otherwise the canonical darks are read in from disk. Raw data frames are accessed in the same way as for darks computation, except that dark subtraction is performed as the frames are loaded into buffers.

The process of computing responsivities from twilight flat sequences consists of a multi-pass linear least-squares fit. The dependent variable for each pixel is the raw value minus the corresponding dark value; the independent variable is frame median of this quantity. The first pass uses all available frames to obtain the coefficients of the linear fit and the standard deviation of the fitting error for each pixel. On the next pass, data points outside N sigma from the first-pass fit are excluded from the computation, where N is specified via NAMELIST (see `SigRej` in section 2.4 above). Similar passes are made until either (a.) the same number of points are retained as on the previous pass; (b.) the number of points retained drops below a specified fraction of the total number of points (see `MinFrac` in section 2.4), in which case the results of the previous pass are used; (c.) a maximum number of passes per pixel is reached (see `MaxPass` in section 2.4). The responsivity of a pixel is then taken to be the slope of the linear fit. The intercept computed as part of the fit is used to make an image which is written to disk and copied back to the darkhist observation-date directory.

The phrase "all available frames" in the preceding paragraph means all frames supplied by the observatory for that evening or morning twilight flat sequence excluding any frames for which the total number of saturated pixels exceeds user-specified thresholds. Frames with excessive saturation are not used in any of the calculations described herein. Both the Read2-Read1 and the Read1 frames are checked for excessive saturation (see `Max1Sat` and `Max2Sat` in section 2.4). Read2-Read1 frames whose medians are too low or too high are also rejected (see `MinMed` and `MaxMed` in section 2.4).

If the number of frames available is below the minimum allowed (see `MinFrms` in section 2.4), the responsivity processing is aborted. The same is true when the range of Read2-Read1 frame medians is too small (see `RngMin` in section 2.4).

The new responsivity images are analyzed for morning-evening differences if both types of scans are available, and they are compared to the canonical ones as described for darks in the previous section. Unlike darks, the responsivity difference analyses also include a requirement on the absolute differences for individual pixels. This test requires the number of pixels with differences beyond the `MaxRDif` threshold not to exceed the `DRLim` limit (see section 2.4). If the differences are within limits, the new results are used, and otherwise the processing of the observation night is halted with an error code of 4 if any high-severity thresholds are exceeded. If only low-severity thresholds are exceeded, then warning messages are issued, a return code of 2 is given to EXEC, and processing of the observation night continues.

The responsivity images for each band are checked for values outside the `RspMax/RspMin` range

(see section 2.4). Pixels found to be out of limits are turned off in the masks for the corresponding band. Mask files for each band are compared to the canonical masks; the number of pixels with different states in same band and read type is reported to the QUALITY subsystem. For each band and read type, if `UseMsk0` (see section 2.4) has *not* been set `T`, then the new mask is written over the old one, i.e., used for processing that night's scans, if a corresponding dark or responsivity image has been found usable or if `UseNMsk` (see section 2.4) has been set `T`. If `AndMsk` (see section 2.4) has its default value of `T`, then the new and old masks are logically ANDed, and the result is written to disk as the new mask.

## 4. Output

The DARKS subsystem produces the following output files.

A.) Some or all of the MRD files (see section 2, item A) for the current observation date; where current products are judged usable, the canonical MRD files previously copied to the darks directory are overwritten. The resulting set of MRD files is used by PIXCAL/DFLAT for scan processing (see SIS DRK01, DRK02, and DRK03 for the responsivity, dark, and mask file specifications, respectively). In addition to the images defined in section 2.1, some or all of the following files may be generated, depending on NAMELIST settings and availability of morning and evening sequences.

| | | |
|---|---|---|
| j_e_dark.fits | : | evening dark for J-band Read2-Read1 frames |
| j_e_darksig.fits | : | trimmed-average sigma of j_e_dark.fits |
| j_m_dark.fits | : | morning dark for J-band Read2-Read1 frames |
| j_m_darksig.fits | : | trimmed-average sigma of j_m_dark.fits |
| j_e_dark_1.fits | : | evening dark for J-band Read1 frames |
| j_e_darksig_1.fits | : | trimmed-average sigma of j_e_dark_1.fits |
| j_m_dark_1.fits | : | morning dark for J-band Read1 frames |
| j_m_darksig_1.fits | : | trimmed-average sigma of j_m_dark_1.fits |
| j_d_dark.fits | : | difference: j_m_dark.fits-j_e_dark.fits |
| j_d_dark_1.fits | : | difference: j_m_dark_1.fits-j_e_dark_1.fits |
| j_n_dark.fits | : | new dark for J-band Read2-Read1 frames |
| j_n_dark_1.fits | : | new dark for J-band Read1 frames |
| j_D_dark.fits | : | difference: j_n_dark.fits-jdark.fits |
| j_D_dark_1.fits | : | difference: j_n_dark_1.fits-jdark_1.fits |
| h_e_dark.fits | : | evening dark for H-band Read2-Read1 frames |
| h_e_darksig.fits | : | trimmed-average sigma of h_e_dark.fits |
| h_m_dark.fits | : | morning dark for H-band Read2-Read1 frames |
| h_m_darksig.fits | : | trimmed-average sigma of h_m_dark.fits |
| h_e_dark_1.fits | : | evening dark for H-band Read1 frames |
| h_e_darksig_1.fits | : | trimmed-average sigma of h_e_dark_1.fits |
| h_m_dark_1.fits | : | morning dark for H-band Read1 frames |
| h_m_darksig_1.fits | : | trimmed-average sigma of h_m_dark_1.fits |
| h_d_dark.fits | : | difference: h_m_dark.fits-h_e_dark.fits |

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|---|---|---|
| h_d_dark_1.fits | : | difference: h_m_dark_1.fits-h_e_dark_1.fits |
| h_n_dark.fits | : | new dark for H-band Read2-Read1 frames |
| h_n_dark_1.fits | : | new dark for H-band Read1 frames |
| h_D_dark.fits | : | difference: h_n_dark.fits-hdark.fits |
| h_D_dark_1.fits | : | difference: h_n_dark_1.fits-hdark_1.fits |
| k_e_dark.fits | : | evening dark for Ks-band Read2-Read1 frames |
| k_e_darksig.fits | : | trimmed-average sigma of k_e_dark.fits |
| k_m_dark.fits | : | morning dark for Ks-band Read2-Read1 frames |
| k_m_darksig.fits | : | trimmed-average sigma of k_m_dark.fits |
| k_e_dark_1.fits | : | evening dark for Ks-band Read1 frames |
| k_e_darksig_1.fits | : | trimmed-average sigma of k_e_dark_1.fits |
| k_m_dark_1.fits | : | morning dark for Ks-band Read1 frames |
| k_m_darksig_1.fits | : | trimmed-average sigma of k_m_dark_1.fits |
| k_d_dark.fits | : | difference: k_m_dark.fits-k_e_dark.fits |
| k_d_dark_1.fits | : | difference: k_m_dark_1.fits-k_e_dark_1.fits |
| k_n_dark.fits | : | new dark for K-band Read2-Read1 frames |
| k_n_dark_1.fits | : | new dark for K-band Read1 frames |
| k_D_dark.fits | : | difference: k_n_dark.fits-kdark.fits |
| k_D_dark_1.fits | : | difference: k_n_dark_1.fits-kdark_1.fits |
| j_e_resp.fits | : | evening resp. for J-band Read1 and Read2-Read1 frames |
| j_e_rsig.fits | : | sigma about linear fit for j_e_resp.fits |
| j_e_ntcp.fits | : | intercept that goes with j_e_resp.fits |
| j_m_resp.fits | : | morning resp. for J-band Read1 and Read2-Read1 frames |
| j_m_rsig.fits | : | sigma about linear fit for j_m_resp.fits |
| j_m_ntcp.fits | : | intercept that goes with j_m_resp.fits |
| j_d_resp.fits | : | difference: j_m_resp.fits-j_e_resp.fits |
| j_n_resp.fits | : | new resp. for J-band Read1 and Read2-Read1 frames |
| j_c_resp.fits | : | canonized j_n_resp.fits (j_n_resp.fits renamed) |
| j_D_resp.fits | : | difference: j_n_resp.fits-jresp.fits |
| h_e_resp.fits | : | evening resp. for H-band Read1 and Read2-Read1 frames |
| h_e_rsig.fits | : | sigma about linear fit for h_e_resp.fits |
| h_e_ntcp.fits | : | intercept that goes with h_e_resp.fits |
| h_m_resp.fits | : | morning resp. for H-band Read1 and Read2-Read1 frames |
| h_m_rsig.fits | : | sigma about linear fit for h_m_resp.fits |
| h_m_ntcp.fits | : | intercept that goes with h_m_resp.fits |
| h_d_resp.fits | : | difference: h_m_resp.fits-h_e_resp.fits |
| h_n_resp.fits | : | new resp. for H-band Read1 and Read2-Read1 frames |
| h_c_resp.fits | : | canonized h_n_resp.fits (h_n_resp.fits renamed) |
| h_D_resp.fits | : | difference: h_n_resp.fits-hresp.fits |
| k_e_resp.fits | : | evening resp. for Ks-band Read1 and Read2-Read1 frames |
| k_e_rsig.fits | : | sigma about linear fit for k_e_resp.fits |
| k_e_ntcp.fits | : | intercept that goes with k_e_resp.fits |
| k_m_resp.fits | : | morning resp. for Ks-band Read1 and Read2-Read1 frames |
| k_m_rsig.fits | : | sigma about linear fit for k_m_resp.fits |
| k_m_ntcp.fits | : | intercept that goes with k_m_resp.fits |
| k_d_resp.fits | : | difference: k_m_resp.fits-k_e_resp.fits |
| k_n_resp.fits | : | new resp. for K-band Read1 and Read2-Read1 frames |

| | | |
|---|---|---|
| k_c_resp.fits | : | canonized k_n_resp.fits (k_n_resp.fits renamed) |
| k_D_resp.fits | : | difference: k_n_resp.fits-kresp.fits |
| j_n_mask.fits | : | new mask for J-band Read2-Read1 frames |
| j_n_mask_1.fits | : | new mask for J-band Read1 frames |
| h_n_mask.fits | : | new mask for H-band Read2-Read1 frames |
| h_n_mask_1.fits | : | new mask for H-band Read1 frames |
| k_n_mask.fits | : | new mask for Ks-band Read2-Read1 frames |
| k_n_mask_1.fits | : | new mask for Ks-band Read1 frames |
| j_N_mask.fits | : | j_n_mask.fits before `AndMsk` processing |
| j_N_mask_1.fits | : | j_n_mask_1.fits before `AndMsk` processing |
| h_N_mask.fits | : | h_n_mask.fits before `AndMsk` processing |
| h_N_mask_1.fits | : | h_n_mask_1.fits before `AndMsk` processing |
| k_N_mask.fits | : | k_n_mask.fits before `AndMsk` processing |
| k_N_mask_1.fits | : | k_n_mask_1.fits before `AndMsk` processing |

B.) Input for the QUALITY subsystem (see SIS's DRK05 and DRK06).

C.) History files are written to the "darkhist" subdirectory of the histn or hists directory (the history directories for the northern and southern hemispheres, respectively) in a subdirectory named after the observation date.

D.) A processing summary.

## 5. Testing

The DARKS subsystem will be tested on protocamera data, for which MRD files have been generated by independent means. Comparisons to these files will be made to determine whether DARKS is functioning properly.

## Glossary

| | |
|---|---|
| darkhist | History-file directory for DARKS data; there is one under histn and one under hists |
| histn | History-file directory for the northern hemisphere |
| hists | History-file directory for the southern hemisphere |
| MRD | Masks, Responsivities, and Darks |
| PCP | Pipeline Control Program |
| SDS | Subsystem Design Specification |
| SIS | Software Interface Specification |
| tls | Tapeload Subsystem |