



omichain

June 2, 2019

Abstract

This document describes how to use the **omichain** perl script to reduce **OM IMAGING** mode data, how it works and what output it produces. Some advisory checks on the output are also discussed.

1 Instruments/Modes

Instrument	Mode
OM	Imaging

2 Use

pipeline processing	yes
interactive analysis	no

3 Description

This package contains a PERL script which processes an ODF set of imaging mode OM files in a pipeline-like mode to produce OM imaging mode pipeline products. The ODF data set files must conform to the filename specification given in the ODF ICD. The **omichain** PERL script will process those image files and produce output files conforming also to the same ICD specifications.

4 Running the omichain

Assuming the environment variables SAS_CCFPATH, SAS_CCF and SAS_ODF have been properly defined to process a given ODF data set, you may proceed to run the omichain by simply executing the command **omichain**, without any parameter.

The location of the ODF files to be processed is obtained from the SAS summary file that is defined in the SAS_ODF environment variable. Should this variable not set or not set properly to be the SAS summary file, omichain will complain and exit with an error message.



All ODF files should be uncompressed. Otherwise some functions in the omichain will not work properly.

It is a good idea to ensure that the SAS environment variable **SAS_VERBOSITY** is set to at least 5 (**setenv SAS_VERBOSITY 5**), so that all messages, warnings and errors from the omichain are displayed.

It is also useful to redirect the output to a log file (**omichain > & omichain.log &**, c-shell).

1. Use the command **omichain outdirectory=some_path** to put all output products in the specified path.
2. In the following, the term **output file** refers to a file created by one one of the **OM SAS** tasks during the run of the omichain. Output products from these tasks are all **FITS** (Flexible Image Transport System) files except those of type ps (PostScript) and pdf (Portable Document Format), which are the byproducts of plotting tasks.
3. Using the default parameter settings, the omichain will process all the image files in the ODF directory. However, if only the images of specific exposures or the images taken with specific filters need to be processed, the parameters **exposures** and **filters**, respectively, can be used to achieve this as follows:
 - (a) To specify which filter/filters to process use the parameter **filters='filter1 filter2 ...'**.
 - (b) To specify which exposure/exposures to process add the parameter **exposures='exposure1 exposure2 ...'**.
4. To perform source-detection on the mosaiced sky-images add the parameter **processmosaicedimages=t**.

Some of the parameters for individual tasks can be set using the appropriate omichain parameter - the parameter names are the same as the task parameter names, prefixed with the name of the task - **Please see Section 9.0.**

4.1 Decreasing processing time

For **ODFs with Engineering 2/4 data** (ie images of dimension 1024x1024 and 2048x2048, respectively), the time taken to process the data may become considerable (in excess of one hour). If time is of importance to you, and you are only interested in the “brighter sources”, a considerable reduction in processing time can be achieved by setting the parameter “**omdetectnsigma**” to 2.01. For this setting, the algorithms in **omdetect** that search for “faint” sources will be bypassed.

5 OPERATION

The following describes the way that an ODF is processed in the default mode. Figure 1 shows the overall operation of the omichain. It is split up into 3 separate pipelines:

- The tracking-history pipeline that processes the spacecraft tracking-history information for each exposure (as shown in Figure 2).
- The imaging pipeline that processes the image from each exposure (as shown in Figure 3).



- The image-stacking and mosaicing pipeline that processes the mosaiced sky-images for each filter (as shown in Figure 4).

5.1 Initial processing

1. The SAS summary file is examined to produce a list of the OM filters that were used in the observation, and for each filter a list of the exposures for that particular filter is also produced.
2. A flatfield (currently a plain flat, with each pixel having the value 1, from the CAL data) is then created by the task **omflatgen**.
3. The chain then scans the input directory to check that the necessary auxilliary files (e.g. tracking history, window files, housekeeping files etc) are present, exiting with an error message if any key files are absent.

5.2 Processing of the data for each filter

The **omichain** cycles through the filters in the filter list and for each one processes each exposure in the exposure list for that filter. The following summarizes the steps taken by the **omichain** in this stage.

1. First it checks to see if the exposure is a full-frame low-resolution mode image (**Engineering 2**), and if so it runs **omcomb** to combine the four separate image segments into a single full-frame image, which is then processed instead of the individual image segments.
2. The tracking-history pipeline (please see Figure 2) is first run to produce tracking history information using **omprep**, **omdrifhist** and **omthconv**.
3. The imaging pipeline (Figure 3) is then run to process the image for this exposure, and the following programs are executed in turn:
 - (a) **omprep** - converts the image from **integer** to **real** and adds some key-words to the header.
 - (b) **omcosflag** - adds the quality array to the image.
 - (c) **omflatfield** - flatfields the image.
 - (d) **ommodmap** - attempts to correct for mod-8 patterning.
 - (e) **omdetect** - detects sources, computes source positions, source moments (semi-major, minor and position angle), raw and corrected count rates, and sets some flags for each source.
 - (f) **omqualitymap** - transfers source quality-flag information from the source-list table to the **QUALITY** image of the image file.
 - (g) **ommag** - computes instrumental magnitudes for each source.
 - (h) **omatt** - computes celestial coordinates (Right-Ascension and declination) from the X and Y pixel coordinates and produces a “sky-image”. If a USNO catalogue fits file is available, and the parameter **usecat** is set to **true** then it will also correct the astrometry for any offset between the OM and USNO RA and dec axes, adding the columns **RA_CORR** and **DEC_CORR** to the source-list. Details about the catalogue fits file are given in the documentation on **omatt** and **omsrlistcomb**. It should be noted that in the case when the USNO subset catalogue is not available but the parameter **usecat** is set to **true**, then the task **omatt** will attempt to generate its own subset of the USNO catalogue by using the *scat* tool from the package WCSTOOLS, which



in this case should be installed on the user's computer. If the package WCSTOOLS is not installed, the task **omatt** will skip the aspect-correcting stage of processing and the output image and source lists will remain uncorrected.

5.3 Production of the mosaiced sky-image

When all the exposures for a given filter have been processed, **ommosaic** is used to combine the low-resolution sky-coordinate images into a single image. **ommosaic will only run if there is at least one sky image for the filter.**) Before using an image the **RA** and **DEC** the astrometric corrections computed by **omatt** are applied to the reference pixel coordinates.

5.4 Production of the combined source-list

Finally, when all the data for each filter has been processed, **omsrlistcomb** runs to combine the source lists from separate exposures into a single master list, to compute source fluxes, standard and AB magnitudes, and to set source flags. As for **omatt**, if a **USNO** catalogue fits file is available, and the parameter **omsrlistcombusecat** is set to **TRUE** then it will also correct the astrometry (using the combined source-list) for any offset between the OM and USNO RA and dec axes, adding the columns **RA_CORR** and **DEC_CORR** to the combined source-list. For more details, please see the documentation on **omsrlistcomb**.

The **omatt** computed astrometric offsets are ignored by **omsrlistcomb**. This is because **omatt** cannot always do an astrometric correction (particularly in the UV) and the **OM** pointing is generally very stable during an observation. **omsrlistcomb** can generally do a more accurate astrometric correction, but those done by **omatt** are useful as a check on the pointing stability.

The parameter **omsrlistcombalignaxes** is used to set the **omsrlistcomb**'s parameter **alignaxes** and defaults to **true**. In the default case **omsrlistcomb** attempts to align the **RA** and **DEC** axes of the input source-list files before constructing the combined source-list containing the unique sources from the multiple detections of a unique source. This can improve the astrometry and reduce the chances of erroneous source matches. Once the combined source-list has been formed an astrometric correction will be computed using the sources in the list. **This parameter should only be set to false if the user has a very good reason that it has not worked very well.**

5.5 Processing of the mosaiced sky-images

This functionality was introduced into **SAS 9** to allow source-detection on the mosaiced sky-images. It will only occur if the optional parameter **processmosaicedimages** is set to true (default is false).

The way in which the mosaiced sky-images are processed is shown in Figure 4 and it works in the following way:

1. Loop through each OM filter present and:
 - Run **omdetect** on the mosaiced sky-image file to produce an output **FITS** source-list file. The **SRCLIST** FITS table in this file will contain **RA** and **Dec** coordinates, computed using the WCS keywords in the FITS header. The photometry will have been done using the mosaiced **EXPOSURE** image in the sky-image file, **and no corrections will have been done for coincidence-losses.**



- Run **ommag** on the source-list file to add instrumental magnitudes to it.
 - Run **omqualitymap** to set source-quality flags using the **QUALITY** image in the mosaiced sky-image file.
2. Run **omsrlistcomb**, using these new source-list files (one per filter) as the input files, to produce a second observation source-list file.
 3. Run **ommergelists** to create a third observation source-list file from the merging of the first two.

6 Checking the output

When the omichain has finished processing the odf, it will list the product files that have been created (product image, source-list and tracking-history files (**all those beginning with P0**)). It is a good idea to do some checking of the output and the following are recommended:

- Use **ds9** to view each product image and display the detected sources on the image by selecting the corresponding **region file**. It may be found that some faint sources have not been detected, in which case it may be worthwhile to re-process the data using the **parameter omdetectnsigma set to 1**, or run the task **omsources** to manually select sources.
- Use **fv** to inspect each **product source-list file**.
- Create a region file from the combined source-list file using the task **sconv**, and then use **ds9** to view a mosaiced image and display the sources by selecting the region file.
- Look at the tracking-history plot file. Bad tracking may effect the astrometry and photometry.

7 Parameters

This section documents the parameters recognized by this task (if any).

Parameter	Mand	Type	Default	Constraints
-----------	------	------	---------	-------------

outdirectory	no	string	current directory	
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Path/name of the output files directory

comment	no	string	User comment	
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User comment to output

filters	no	List of filters		
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List of OM filters to be processed



exposures	no	List of exposures		
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List of OM exposures to be processed

ommodmapbox	no	integer	16	
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ommodmap - Size of sliding box in units of 8 pixels

ommodmapsig	no	integer	3	
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ommodmap - Significance level for sigma clipping

omdetectnsigma	no	float	2.	1.0:
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omdetect - number of σ above background mode required for a pixel to be regarded as being part of a source

omdetectdetectextended	no	boolean	T	
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omdetect - Run the algorithm that looks for extended sources

omdetectminsignificance	no	float	3.	1.0:
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omdetect- Minimum significance of a source to be included in the source-list file

usecat	no	boolean	T	
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omatt - Use the USNO-SA 1 catalog for correcting the star positions

catfile	no	string	usno-catalogue file	usnocat.fits
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Name of usno-catalogue fits file

omattrotateimage	no	boolean	T	
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omatt - Create the rotated sky-image

omsrlistcombnsigma	no	float	3.0	
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omsrlistcomb- Used in source-matching number of σ above which two sources are treated as different



omsrlistcombusecat	no	boolean	T	
---------------------------	----	---------	---	--

omsrlistcomb - Use the USNO-SA 1 catalog for correcting the star positions

omsrlistcombalignaxes	no	boolean	T	
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omsrlistcomb - If true (default) omsrlistcomb attempts to align all the images to a common RA/DEC origin.

maxradecerr	no	real	1.0	
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Maximum allowed RA/dec error in astrometry fit.

maxrmsres	no	real	1.5	
------------------	----	------	-----	--

Maximum allowed rms residual in astrometry fit.

processmosaicimages	no	boolean	F	
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Process the mosaiced sky-images

ommergelistsregionfile	no	string		
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Region file name for ommergelists

ommergelistsplotfile	no	string		
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File name for ommergelists plot file

ommergeliststolerance	no	float	2.	1.0:10.0
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Tolerance (arcsecs) used by ommergelists in source-matching

psfphotometryenabled	no	boolean	F	
-----------------------------	----	---------	---	--

Allows using the PSF-photometry method by the task omdetect; If true then sources with close neighbours will have their photometry recomputed using point-spread-function fitting. Please note that in the current version of omdetect this method is under development and its use is currently disabled.

backgroundmethod	no	integer	1	1:7
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Specifies the method for the point-source background determination by the omdetect task (related the PSF-photometry parameter).

maxrawcounttrate	no	float	50.	0.0:
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A count-rate shreshold limiting the applicability of the PSF-photometry method in the task *omdetect*.

rawattitude	no	integer	1	0:2
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Specifies the usage of attitude data by the task *omprep*: if set to 0, the attitude data is used according to the system variable SAS_ATTITUDE (either RAF or AHF); if set to 1, the raw attitude data (RAF) averaged over the first 20 seconds of exposure are used, if set to 2 then the raw attitude data are used averaged over the entire exposure.

8 Errors

This section documents warnings and errors generated by this task (if any). Note that warnings and errors can also be generated in the SAS infrastructure libraries, in which case they would not be documented here. Refer to the index of all errors and warnings available in the HTML version of the SAS documentation.

SAS_ODF is not defined ! Please define it and rerun (*fatal*)

The SAS_ODF environment variable has not been defined. It must be defined as the full file specification of the SAS summary file

SAS_ODF does not point to the SAS summary file (*fatal*)

The SAS_ODF environment variable is defined but points to a directory, not to the SAS summary file (SUM.SAS), as produced by the **odfingest** task

Task Failure (*fatal*)

There has been a failure in the specified task, preventing the **omichain** from continuing

The ODF does NOT contain a Periodic Housekeeping file (*fatal*)

The **omichain** cannot proceed further because it needs to use information from the periodic housekeeping file

The ODF does NOT contain a Non-Periodic Housekeeping file (*fatal*)

The **omichain** cannot proceed further because it needs to use information from the non-periodic housekeeping file

9 Input Files

Except for the **SAS** summary file, which is an ascii file, all the others are **FITS** files.

1. rrrr_iiii_iiiiii_SCX00000SUM.SAS - SAS summary file- produced by odfingest
2. rrrr_iiii_iiiiii_SCX00000NPH.FIT - OM Non-periodic Housekeeping file
3. rrrr_iiii_iiiiii_SCX00000PEH.FIT - OM Periodic Housekeeping file
4. rrrr_iiii_iiiiii_SCX00000TCS.FIT - Spacecraft time correlation file
5. rrrr_iiii_iiiiii_SCX00000ATS.FIT - Spacecraft attitude history file



6. rrrr_iiii_iiiiii_SCX00000RFX.FIT - Spacecraft priority reference-frame data.

For each exposure to be processed there are also files:

1. rrrr_iiii_iiiiii_OMSeeewwTHX.FIT - OM Tracking History Data Auxiliary file
2. rrrr_iiii_iiiiii_OMSeeewwWDX.FIT - OM Priority Window Data Auxiliary file

where **rrrr** is the 4 digit XMM rev. number, **iiii_iiiiii** is the 10 digit observation id, **eee** is the exposure number (e.g. 006 etc.), and **ww** is the window identifier (00 or 01).

If **THX**-file are not present, no tracking corrections can be applied but this is often not critical since XMM's tracking appears to be good to around 1 arc-second. If **THX** files are absent, a dummy file is created by *omprep*.

10 Pipeline Processing System (PPS) Product Files

Nearly all the product files are in **FITS** file format, with the extension **FIT**, and all begin with the letter **P**. In the following examples of file names, **XX** represents a code for an **OM** filter-**XX=U for U filter, B for B filter, V for V filter, WL for WHITE (unfiltered), W1 for UVW1, M2 for UVM2 and W2 for UVW2**. In what follows, **OSW** stands for **OM Science Window**.

10.1 Flatfield file

1. PPS OSW full-frame Flatfield Image (produced by omflatgen) - eg P00700123700101X000FLAFLD0000.FIT

Please note that the all the pixels of the flatfield image contained in this file have a value of 1.

10.2 Tracking-history files

1. PPS Tracking History plot postscript file (produced by omdrifthist) - eg P0123700101OMS004TSHPLT0000.ps
2. PPS Tracking History Plot pdf file (produced using ps2pdf) - eg P0123700101OMS004TSHPLT0000.PDF
3. PPS Track Star Time Series (fits file) (produced by omthconv) - eg P0123700101OMS004TSTRTS0000.FIT

Please note that occasionally tracking-history information is unavailable for an exposure and in such cases these files will not be absent.

10.3 Images

1. PPS OSW Image (unrotated, produced by **ommodmap**) - eg P0123700101OMS004IMAGE_1000.FIT
2. PPS OSW Sky-coord Image (rotated, produced by **omatt**) - eg P0123700101OMS004SIMAGE2000.FIT
3. PPS Mosaiced sky-image for each filter (produced by **ommosaic**) - eg P0123920101OMS000RSIMAGXX.FIT



10.4 Source-list files- all FITS format

1. Exposure Source-list (file produced by `omdetect`, `ommag` and `omatt`) - eg P0123700101OMS005SWSRLI2000.FIT
2. Observation source-list file produced by `omsrlistcomb` using exposure source-list) - eg P0123920101OMCOMBOBSMLI0000.FIT

The following files will only be produced if the parameter **processmosaicedimages** is set to true.

1. Source-list produced from source-detection on mosaiced sky-image - eg P0123920101OMS000RSISWSS.FIT
2. Observation source-list produced by **omsrlistcomb** using mosaiced-detection source-lists - eg P0123920101OMCOMBOBSMOS0000.FIT
3. Observation source-list produced by **ommerge**lists - eg P0123920101OMCOMBOBSMER0000.FIT

10.5 Mod-8 corrected image file

Ommodmap produces a **mod-8 corrected** image from the intermediate image produced by **omprep**.

1. **Mod-8 corrected image produced by ommodmap**- eg P0123920101OMS006IMAGE_1000.FIT or P0135720601OMS017FIMAG_V000.FIT

The latter will be produced if **omcomb** has run on **engineering-2 data**.

10.6 Rotated sky images (FITS files)

Omatt produces a rotated sky-image (RA-DEC). The **SAS** task **slconv** can be used to produce a **ds9** region file from the source-list file produced by **omatt**, and then the sky image can be displayed using **ds9** and the sources displayed using the region file. **Ommosaic** produces a sky image, for a given filter, from all the sky-images produced by **omatt** for that filter.

1. Sky image produced by **omatt** - eg P0123920101OMS006SIMAGE1000.FIT
2. Sky image produced by **ommosiac** for a given filter - eg P0123920101OMS000RSIMAGV.FIT

10.7 Source-list files (fits)

Omatt produces the first **product** source-list file, for a given exposure number and window identifier. When all the images have been processed, **omsrlistcomb** produces a combined-source list file by merging all the data in the individual product source lists.

1. Product source-list files produced by **omatt** - eg P0123920101OMS006SWSRLI1000.FIT
2. Product combined source-list file produced by **omsrlistcomb** - eg P0123920101OMCOMBOBSMLI0000.FIT



10.7.1 Region files

A ds9 region file can be produced from either of these source-list files by running the SAS task slconv, which can then be used to display the sources when ds9 is used to display a rotated image.

11 Example output from the omichain

The following is an example of a listing of the product files produced by the omichain. The column Astrometry correction indicates if a successful astrometry correction was performed (YES or NO). The observation product files are first listed (apart from the flatfield image file, since all the image pixels are unity), followed by the product files for each filter and then finally tracking-history product files. If no tracking-history information was available, there will be none of the latter files.

There can be up to three product observation source-list files:

- If source-detection was only performed on the exposure images (default- processmosaiced-images=false), there will only be one observation source-list file (TYPE EXPOSURES in the output below).
• If, however, source-detection was also performed on the mosaiced sky-images (processmosaicedimages=true) then there will be two more observation source-list files:
- One obtained from the processing of the mosaiced sky-images (TYPE MOSAICED in the output below), and
- One obtained from the merging of the two previous observation source-list files into one by ommergelists (TYPE MERGED in the output below).

```
omichain:- *****
omichain:- Product Files produced by the omichain
omichain:- *****
omichain:-          TYPE      Observation source-list file      Astrometry correction
omichain:-  1)          MERGED      P01239201010MCOMBOBSMLI_MER.FIT          YES
omichain:-  2)          MOSAICED     P01239201010MCOMBOBSMOS0000.FIT          YES
omichain:-  3)          EXPOSURES     P01239201010MCOMBOBSMER0000.FIT          YES
omichain:- Filter UVM2
omichain:- Mosaiced sky-image=P01239201010MS00ORSIMAGM.FIT, source-list=P01239201010MS00ORSISWSM.FIT
omichain:-          Image file          Sky-image file          Source-list file          Astrometry correction
omichain:-  1)  P01239201010MS011IMAGE_0000.FIT  P01239201010MS011SIMAGE0000.FIT  P01239201010MS011SWSRLI0000.FIT  NO
omichain:-  2)  P01239201010MS011IMAGE_1000.FIT  P01239201010MS011SIMAGE1000.FIT  P01239201010MS011SWSRLI1000.FIT  NO
omichain:-  3)  P01239201010MS505IMAGE_0000.FIT  P01239201010MS505SIMAGE0000.FIT  P01239201010MS505SWSRLI0000.FIT  NO
omichain:-  4)  P01239201010MS505IMAGE_1000.FIT  P01239201010MS505SIMAGE1000.FIT  P01239201010MS505SWSRLI1000.FIT  NO
omichain:-  5)  P01239201010MS506IMAGE_0000.FIT  P01239201010MS506SIMAGE0000.FIT  P01239201010MS506SWSRLI0000.FIT  NO
omichain:-  6)  P01239201010MS506IMAGE_1000.FIT  P01239201010MS506SIMAGE1000.FIT  P01239201010MS506SWSRLI1000.FIT  NO
omichain:-  7)  P01239201010MS507IMAGE_0000.FIT  P01239201010MS507SIMAGE0000.FIT  P01239201010MS507SWSRLI0000.FIT  NO
omichain:-  8)  P01239201010MS507IMAGE_1000.FIT  P01239201010MS507SIMAGE1000.FIT  P01239201010MS507SWSRLI1000.FIT  NO
omichain:-  9)  P01239201010MS508IMAGE_0000.FIT  P01239201010MS508SIMAGE0000.FIT  P01239201010MS508SWSRLI0000.FIT  NO
omichain:- 10)  P01239201010MS508IMAGE_1000.FIT  P01239201010MS508SIMAGE1000.FIT  P01239201010MS508SWSRLI1000.FIT  NO
omichain:- Filter UVW1
omichain:- Mosaiced sky-image=P01239201010MS00ORSIMAGL.FIT, source-list=P01239201010MS00ORSISWSL.FIT
omichain:-          Image file          Sky-image file          Source-list file          Astrometry correction
omichain:-  1)  P01239201010MS010IMAGE_0000.FIT  P01239201010MS010SIMAGE0000.FIT  P01239201010MS010SWSRLI0000.FIT  NO
omichain:-  2)  P01239201010MS010IMAGE_1000.FIT  P01239201010MS010SIMAGE1000.FIT  P01239201010MS010SWSRLI1000.FIT  YES
omichain:-  3)  P01239201010MS501IMAGE_0000.FIT  P01239201010MS501SIMAGE0000.FIT  P01239201010MS501SWSRLI0000.FIT  NO
omichain:-  4)  P01239201010MS501IMAGE_1000.FIT  P01239201010MS501SIMAGE1000.FIT  P01239201010MS501SWSRLI1000.FIT  YES
omichain:-  5)  P01239201010MS502IMAGE_0000.FIT  P01239201010MS502SIMAGE0000.FIT  P01239201010MS502SWSRLI0000.FIT  NO
omichain:-  6)  P01239201010MS502IMAGE_1000.FIT  P01239201010MS502SIMAGE1000.FIT  P01239201010MS502SWSRLI1000.FIT  YES
omichain:-  7)  P01239201010MS503IMAGE_0000.FIT  P01239201010MS503SIMAGE0000.FIT  P01239201010MS503SWSRLI0000.FIT  NO
omichain:-  8)  P01239201010MS503IMAGE_1000.FIT  P01239201010MS503SIMAGE1000.FIT  P01239201010MS503SWSRLI1000.FIT  YES
omichain:-  9)  P01239201010MS504IMAGE_0000.FIT  P01239201010MS504SIMAGE0000.FIT  P01239201010MS504SWSRLI0000.FIT  NO
omichain:- 10)  P01239201010MS504IMAGE_1000.FIT  P01239201010MS504SIMAGE1000.FIT  P01239201010MS504SWSRLI1000.FIT  YES
```



```

omichain:- Filter UVW2
omichain:- Mosaiced sky-image=P0123920101OMS000RSIMAGS.FIT, source-list=P0123920101OMS000RSISWSS.FIT
omichain:-
Image file                               Sky-image file                               Source-list file                               Astrometry correction
omichain:- 1)  P0123920101OMS012IMAGE_0000.FIT  P0123920101OMS012SIMAGE0000.FIT  P0123920101OMS012SWSRLI0000.FIT  NO
omichain:- 2)  P0123920101OMS012IMAGE_1000.FIT  P0123920101OMS012SIMAGE1000.FIT  P0123920101OMS012SWSRLI1000.FIT  NO
omichain:- 3)  P0123920101OMS509IMAGE_0000.FIT  P0123920101OMS509SIMAGE0000.FIT  P0123920101OMS509SWSRLI0000.FIT  NO
omichain:- 4)  P0123920101OMS509IMAGE_1000.FIT  P0123920101OMS509SIMAGE1000.FIT  P0123920101OMS509SWSRLI1000.FIT  NO
omichain:- 5)  P0123920101OMS510IMAGE_0000.FIT  P0123920101OMS510SIMAGE0000.FIT  P0123920101OMS510SWSRLI0000.FIT  NO
omichain:- 6)  P0123920101OMS510IMAGE_1000.FIT  P0123920101OMS510SIMAGE1000.FIT  P0123920101OMS510SWSRLI1000.FIT  NO
omichain:- 7)  P0123920101OMS511IMAGE_0000.FIT  P0123920101OMS511SIMAGE0000.FIT  P0123920101OMS511SWSRLI0000.FIT  NO
omichain:- 8)  P0123920101OMS511IMAGE_1000.FIT  P0123920101OMS511SIMAGE1000.FIT  P0123920101OMS511SWSRLI1000.FIT  NO
omichain:- 9)  P0123920101OMS512IMAGE_0000.FIT  P0123920101OMS512SIMAGE0000.FIT  P0123920101OMS512SWSRLI0000.FIT  NO
omichain:- 10) P0123920101OMS512IMAGE_1000.FIT  P0123920101OMS512SIMAGE1000.FIT  P0123920101OMS512SWSRLI1000.FIT  NO
omichain:-
Tracking-history time-series file           Tracking-history ps file                       Tracking-history pdf file
omichain:- 1)  P0123920101OMS012TSTRTS000.FIT  P0123920101OMS010TSHPLT000.ps  P0123920101OMS010TSHPLT000.PDF
omichain:- 2)  P0123920101OMS509TSTRTS000.FIT  P0123920101OMS501TSHPLT000.ps  P0123920101OMS501TSHPLT000.PDF
omichain:- 3)  P0123920101OMS510TSTRTS000.FIT  P0123920101OMS502TSHPLT000.ps  P0123920101OMS502TSHPLT000.PDF
omichain:- 4)  P0123920101OMS511TSTRTS000.FIT  P0123920101OMS503TSHPLT000.ps  P0123920101OMS503TSHPLT000.PDF
omichain:- 5)  P0123920101OMS512TSTRTS000.FIT  P0123920101OMS504TSHPLT000.ps  P0123920101OMS504TSHPLT000.PDF
omichain:- *****
omichain:- Finished running SAS task OMICHAIN V1.48 Tue Mar 31 11:16:56 UTC 2009
omichain:- *****

```

12 Intermediate Output Files

All intermediate files begin with the letter **I**.

12.1 Exposure Flatfield

One flatfield per exposure is produced by **omflatfield**

1. eg I0123920101OMS006FLATF1000.FIT

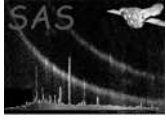
Please note that the flatfield image contained in this file will have all pixels set to 1.

12.2 Unrotated image-files (fits)

Omprep produces the first intermediate image file, by converting the **integer** image in a raw image file into a **real** image and adding some keywords to the fits header. **Omcosflag** then adds a **Quality image** to this same file. **Omflatfield** then flatfields this image by dividing it by the master flatfield produced by **omflatgen**.

1. Real image file produced by omprep - eg I0123920101OMS006IMAGE10000.FIT
2. Image file modified by omcosflag - eg I0123920101OMS006IMAGE10000.FIT
3. Image file produced by **omflatfield** - eg I0123920101OMS006IMAGE20000.FIT
4. Image file produced by **omcomb** - eg I0135720601OMS01700E2I.FIT

Please note that the latter image is only produced if there are 3 or 4 engineering-2 exposures.



12.3 Flat-field file

1. Flat-field file produced by **omflatfield** - eg I0123920101OMS006FLATF1000.FIT

12.4 Mod-8 tile image map

1. Mod-8 tile image map produced by **ommodmap**- eg I0123920101OMS488MOD81000.FIT

12.5 Source-list files (fits)

Two intermediate source-list files are produced for each image- the first is produced by **omdetect** and then this is modified by **ommag** (magnitudes are added).

1. Intermediate source-list file produced by **omdetect** - eg I0123920101OMS006SWSRLI10000.FIT
2. Intermediate source-list file produced by **ommag** - eg I0123920101OMS006SWSRLI10001.FIT

12.6 Region files (ascii)

A region file is produced by **omdetect**, and this can be used to display the sources when a sky-image is displayed using **ds9**.

1. Region file produced by **omdetect** I0000110101OMS004REGION0000.ASC

12.7 Level-image files (fits)

This image-file is produced by **omdetect** and the image shows the pixels assigned to each source- the value assigned to each pixel corresponds to the number of the source in the source-list file.

1. Intermediate level-image file produced by **omdetect** - eg I0123920101OMS493LEVELIMAGE1000.FIT

12.8 Background-image files (fits)

This image-file is produced by **omdetect** and the image shows the final background map it produced after running the source-detection algorithms.

1. Intermediate background-image file produced by **omdetect** - eg I0123920101OMS493BCKIMAGE1000.FIT

12.9 Engineering-2 data

1. For engineering-2 mode data, the four image segments are combined into a composite image by **omcomb** (fits file, eg I0135720601OMS01700E2I.FIT) which is then processed in the normal way.



13 Comments

- Pipeline product filenames have the extensions **ps**, **PDF** and **FIT**.

14 Future developments

Presently, the tabulated source positions suffer from an unknown offset in RA and declination, which could be up to 10 arcsecs or more. The program `omatt`, which calculates the equatorial coordinates of the sources, can in fact calculate these offsets and correct the positions, but only if it has access to a star catalogue. Unfortunately, at present no catalogue is available and hence no correction can be applied. It is hoped that in the near future a catalogue will be provided with each ODF set, enabling an astrometric correction to be made.



THE OMICHAIN - SCHEMATIC DIAGRAM

INPUT FILES

SAS ODF FILES

LOOP THROUGH EACH OM FILTER

LOOP THROUGH EACH EXPOSURE FOR THE FILTER AND

- 1) RUN THE TRACKING HISTORY PIPELINE (See diagram 2)
- 2) RUN THE IMAGING PIPELINE (See diagram 3)

END EXPOSURE LOOP

RUN OMMOSAIC

imagesets=list of sky images mosaicedset=mosaiced sky image exposuremap=yes

END OM FILTER LOOP

RUN OMSRCLISTCOMB (Produce observation source-list file)

sourcelistsets=list of product sourcelist files outset=product_observation_source-list file

RUN THE MOSAICED SKY-IMAGE PIPELINE (See diagram 4)

OUTPUT PRODUCT FILES

- 1) IMAGE FILES (ONE PER EXPOSURE)
- 2) SKY-IMAGE FILES (ONE PER EXPOSURE)
- 3) SOURCE-LIST FILES (ONE PER EXPOSURE)
- 4) MOSAICED SKY-IMAGE (ONE PER FILTER)
- 5) MOSAICED-SKY SOURCE-LIST FILE (ONE PER FILTER)
- 6) OBSERVATION SOURCE-LIST FILE (up to 3)
- 7) TRACKING-HISTORY PLOT FILES (2) (one ps and one pdf file)
- 8) TRACKING-HISTORY TIME-SERIES FILE

Figure 1: Task sequence of the omichain



OMICHAIN TRACKING-HISTORY PIPELINE

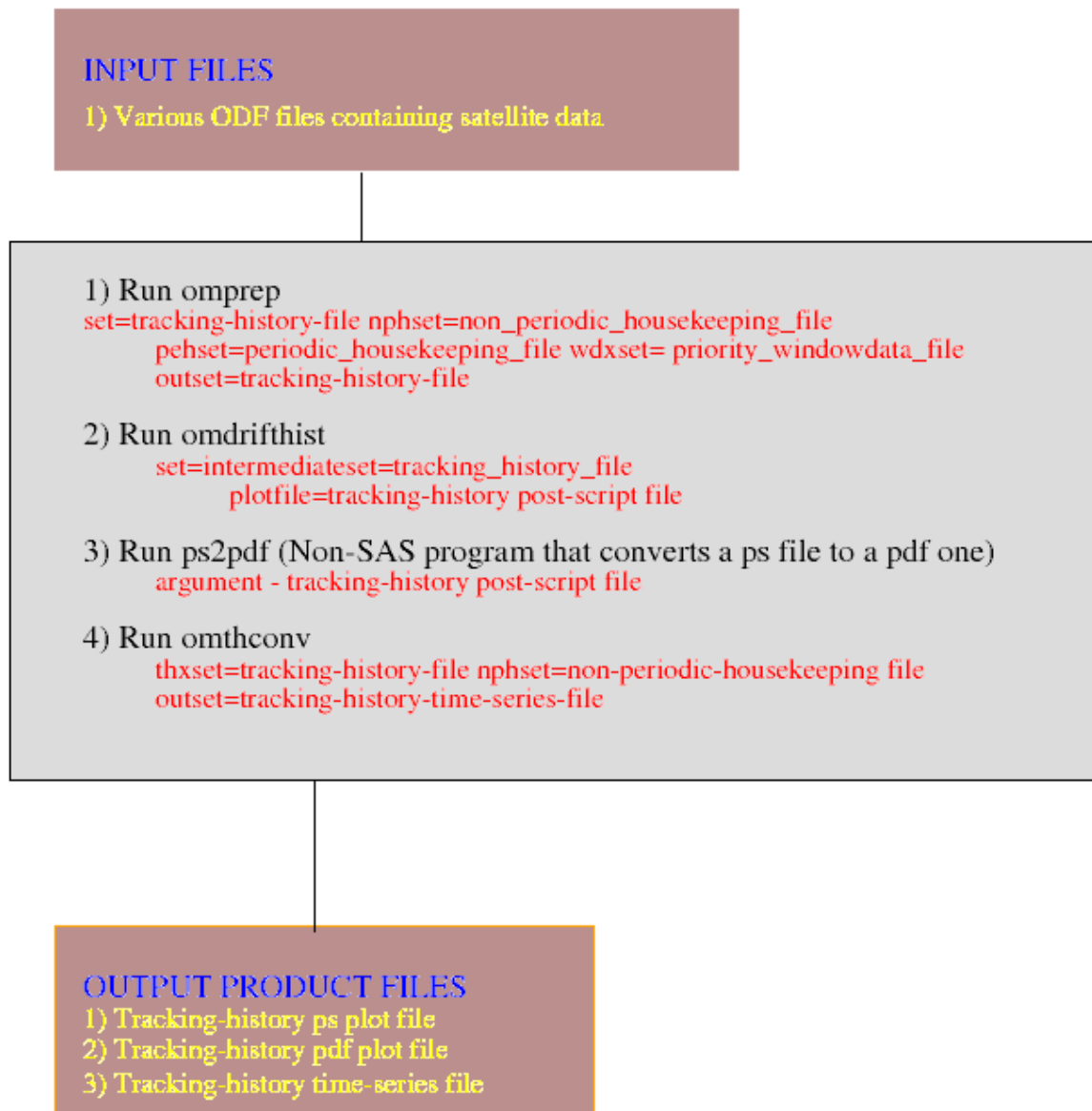


Figure 2: Task sequence of the omichain tracking-history pipeline



OMICHAIN IMAGING PIPELINE

INPUT FILES

1) RAW IMAGE FILE

1) Run omprep

set=image-file nphset=non-periodic-housekeeping-file
pehset=periodic-housekeeping-file wdxset= priority-windowdata-file
outset=intermediate-image-file1

2) Run omcosflag

set=intermediate-image-file1 thxset=tracking-history-file

3) Run omflatfield

set=intermediate-image-file1 thxset=tracking-history-file
tsflatset=product-flatfield-file outset=intermediate-image-file2

4) Run ommodmap

set=intermediate-image-file2 outset=product-image-file mod8product=yes mod8set=mod8-file

5) Run omdetect

set=product-image-file outset=intermediate-sourcelist-file regionfile=ds9-region-file
levelimage=levelimagefile backgroundimage=background-image-file
nsigma=2 minsignificance=3

6) Run omqualitymap (Set QUALITY image pixels)

set=product-image-file srclistset=product-sourcelist-file
outset=product-image-file mode=setqualityimage

7) Run ommag

set=product-sourcelist-file

8) Run omatt

set=product-image-file sourcelistset=product-sourcelist-file ppsoswset=product-skyimage-file
usecat=no rotateimage=yes tolerance=3 catfile=usnocat.fit maxradecerr=1 maxrmsres=1
outset=product-image-file nsig=3 nbox=4

OUTPUT PRODUCT FILES

1) PRODUCT IMAGE FILE

2) PRODUCT SKY-IMAGE FILE

3) PRODUCT SOURCE-LIST FILE

Figure 3: Task sequence of the omichain imaging pipeline



OMICHAIN MOSAICED -IMAGING CHAIN

OBJECTIVE- To increase the detection limiting-magnitude by source-detection on the mosaiced sky images

INPUT PRODUCT FILES

- 1) Mosaiced sky image (from ommosaic- one per filter)
- 2) Observation source-list file (from omsrclistcomb)

Stage 1 - For each mosaiced sky-image

1) Run omdetect

```
set=mosaicimage outset=mosaicedsrclist nsigma=2 minsignificance=3  
outset=mosaicedsrclist
```

2) Run omqualitymap (set source quality flags)

```
set=mosaicimage srclistset=mosaicedsrclist mode=usequalityimage  
outset=mosaicedsrclist
```

3) Run ommag

```
set=mosaicedsrclistset
```

Stage 2 - Creating a list of the new sources

1) Run omsrclistcomb

```
sourcelistsets="mosaicedsrclistset1 ..." usecat=true catfile=usnocat.fits  
outset=obssrclist2
```

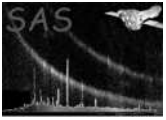
2) Run ommergelists

```
srclist1=obssrclist1 srclist2=obssrclist2  
outset=obssrclist3
```

NEW PRODUCT FILES

- 1) Source-list file (one per mosaiced sky image)
- 2) Second observation source-list file
- 3) Third observation source-list file

Figure 4: Task sequence of the omichain mosaiced-imaging pipeline



References