CORIMP

An IDL widget tool for coronal image processing

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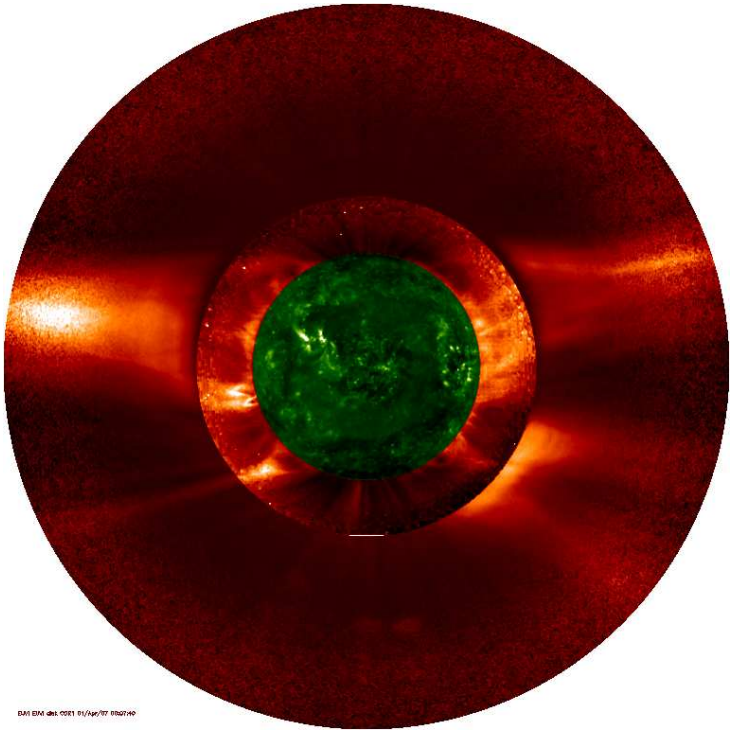


Background

Funded by a grant from the COR1 team at Goddard SFC, CORIMP was originally written to process STEREO / SECCHI COR1 coronagraph images. CORIMP soon developed to have a broader application. It is designed to take the pain out of creating multi-instrument composite images, i.e. images of nested coronagraph and solar disk observations. The image above is produced using CORIMP, and shows an EUVI image of the disk in green, the lowermost corona in red, again from EUVI, and a COR1 image of the extended inner corona, again in red.

Questions or comments about CORIMP should be emailed to Huw Morgan at the address above. Please include the word 'CORIMP' in the subject field of your email. Huw works for the Instiute for Astronomy, University of Hawaii, and for Aberystwyth University in Wales.

The software will undoubtedly be improved and expanded, and any updates will be automatically included with updates to your Solar Software package.

Content

1. Instruments supported—see also Appendix 1

CORIMP currently supports the following instruments:

Ground Based:
MLSO MKIII and MKIV Cartesian fits files

SOHO:
EIT
LASCO C2 & C3 (total brightness and polarized brightness)

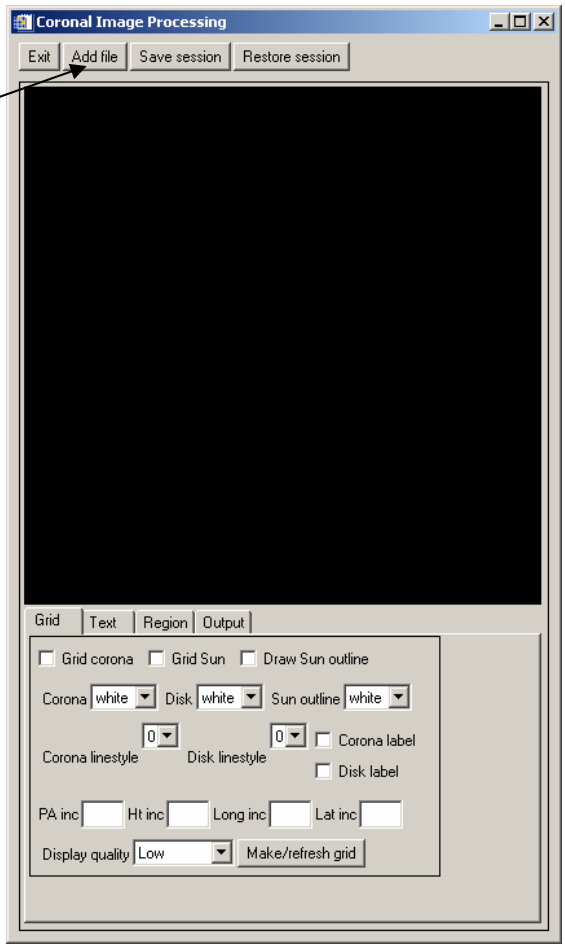
STEREO SECCHI:
EUVI
COR1 & COR2 (total brightness and polarized brightness)
HI is included, but has not been tested at all yet

2. Installing and launching

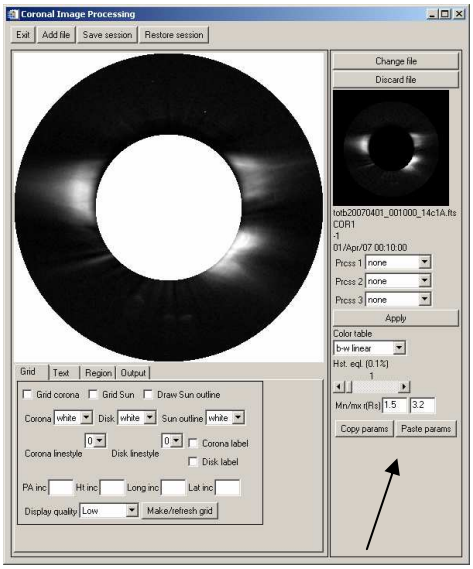
- Launch an IDL solar software session with the appropriate instrument environment (see main solar software documentation for more details). If you want to use CORIMP to process, for example, SECCHI observations, you should be working in a SECCHI solar software session.
- Make sure IDL can see your CORIMP directory. In IDL Development Enviroment, this can be set under File>Preferences>Path. In command line IDL, you must ensure that the CORIMP directory is included in the !PATH system variable.
- Launch CORIMP by typing corimp in the IDL command prompt. This starts the main CORIMP widget interface.

3. Opening files

The image on the right shows the main CORIMP widget interface. To open a fits file for viewing, click on **Add file**.

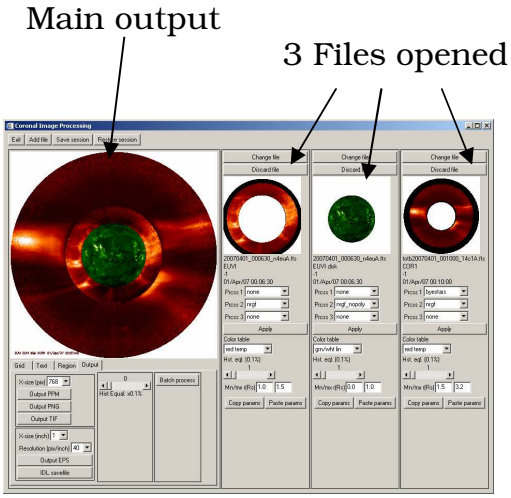


You will be asked to select a data file, and CORIMP will open it using the appropriate SSW routines (for example, SECCHI_PREP, LASCO_READFITS, etc.).



CORIMP opens a new column widget for each new file opened. These columns allow independent processing of each file. If you open a second file, again using **Add file**, a second column will appear to contain the new file. The screenshot below shows three files opened, with the nested main output displayed in the main CORIMP widget.

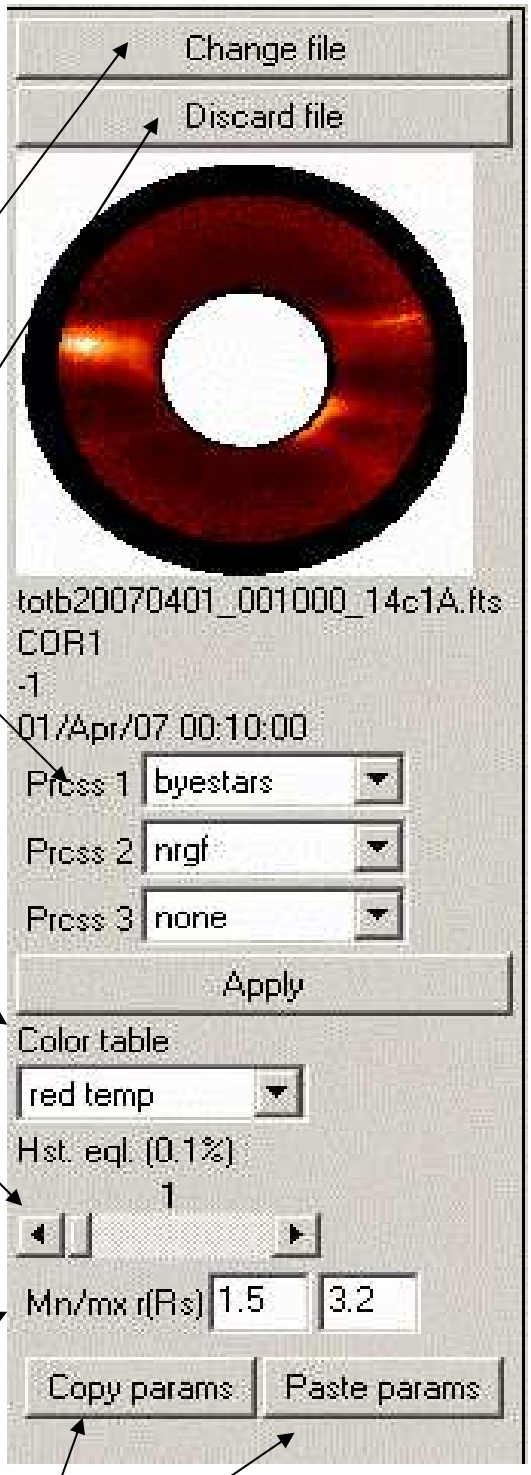
NOTE: When you open a file containing observations of the disk (EIT or EUVI), CORIMP treats the file as two separate observations. This enables independent processing of the disk and off-limb corona.



NOTE: You can select a set of files which make a complete polarization sequence. See Appendix 1

See Appendix 1 for more details of opening files, background subtraction etc.

4. Manipulating files



The image on the right shows the main widget column for manipulating a single opened file.

If you wish to change the file, click on **Change file**. This is useful if you want to keep the parameters in the column, but just change the file.

Discard file will close the widget column, and the file is discarded from your current session.

You can apply 3 separate image processing methods on the image in succession. Select these methods using the dropdown lists of **Prcss1, 2 and 3.** After selecting the desired processes, click **Apply.** See Appendix 2 for a description of the image processing methods included, and how to add your own processes.

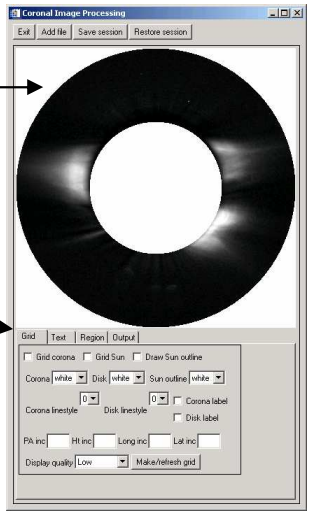
The **Color table** dropdown list allows you to use separate color tables for each separate file.

The **Hst. Eql.** slider allows individual setting of contrast enhancement for each separate file. The slider increments in units of 0.1%.

The **Mn/mx r(Rs)** shows two numbers which can be edited. These define the height range, in solar radii, which the image forms in the main output image. Sensible default values have been set for the various instruments. In this example, the COR1 instrument goes from 1.5 to 3.2Rs. If you edit one of these numbers, make sure to press enter (changing the number does not make a difference until you press enter).

Copy params copies all the parameters within the column. You can then **Paste params** to a different file column.

5. Manipulating output



The **main output window** contains the main output image.

Under the image are a series of tab menus containing options for the output graphic:

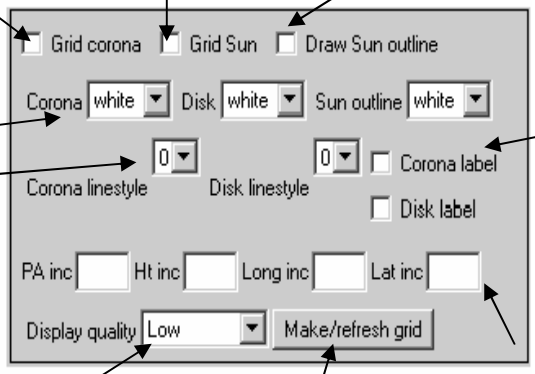
We now look at each tab menu in turn.

Grid
Options for gridding coordinates on the image.

Select tickbox **Grid corona** to add position angle and height grid to the corona.

Select tickbox **Grid Sun** to add longitude and latitude grid to the disk.

Select tickbox **Draw Sun outline** to draw a circle at the position of the Sun's limb.



Under the 3 tickboxes are options for changing the color and linestyle of the grids.

Adds coordinate labels to the grid.

PA inc, Ht inc, Long inc and **Lat inc** allow the user to specify gridding increments in position angle, height, longitude and latitude respectively, rather than using the default values.

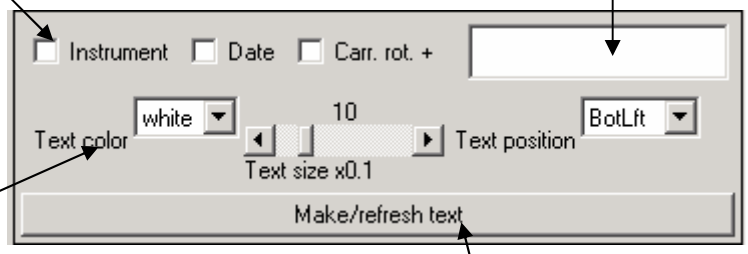
You can choose low or high display quality for the gridding.

After you have chosen all your grid options, press **Make/refresh grid** to display, or redisplay, the grid.

Text
Options for adding text to the image.

Select tickboxes **Instrument, Date or Carr. Rot.** to add instrument names, date or Carrington rotation in a text string

Use text field to add your own text

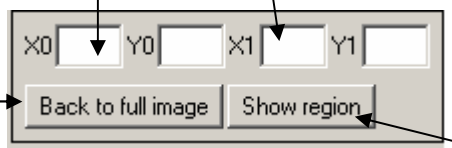


Options for text color, size and position.

After you have chosen all your text options, press **Make/refresh text** to display, or redisplay, the text.

Region
Options for choosing a subregion of the main image for output. **Note that you can use the mouse on the main output window to select regions! Click and hold down the mouse button on the image to define one corner of the region, release the mouse at the desired opposite diagonal corner.**

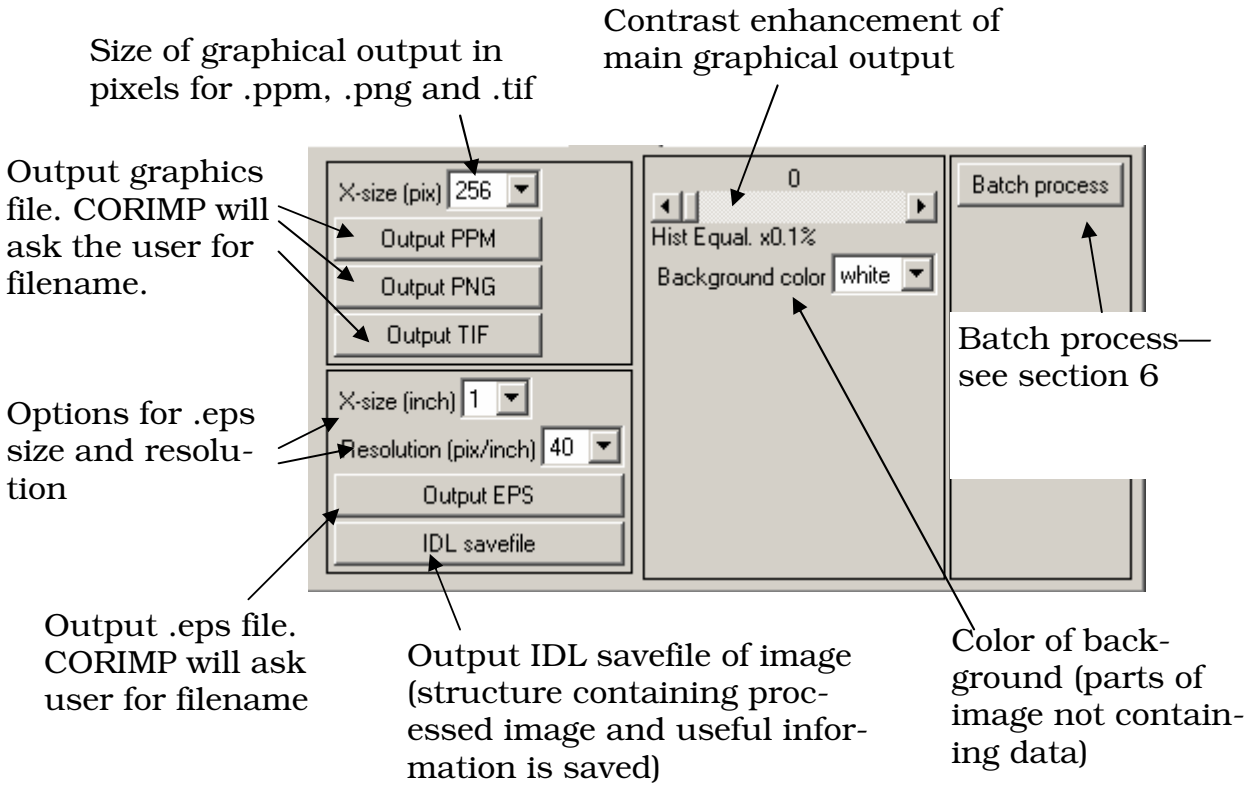
Editable text fields specify the lower left corner and top right corner of selected region



Back to full image

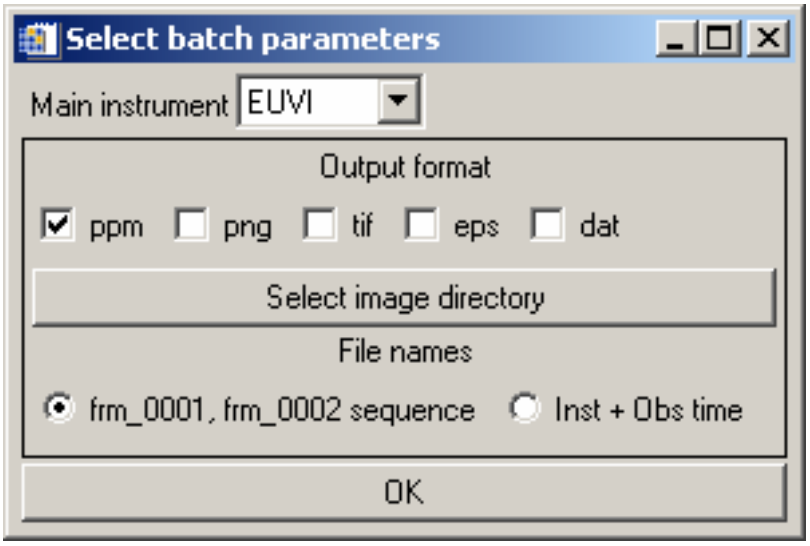
Display the region specified in text boxes X0, Y0, X1 and Y1.

Output
Options for creating graphical output.



6. Batch Processing

Clicking on **Batch process** in the Output tab field opens a new set of routines for processing large sets of data, based on the content currently set up in your CORIMP session. So, let's assume you have a EUVI and COR1 composite image displayed nicely in your CORIMP output window, but you have a series of such images to produce. Use Batch Process to process all the files with the same parameters as specified in your current CORIMP session. Batch process will first ask you to select lists of files for each instrument ('Please choose COR1 files', 'Please choose EUVI files' etc.). Note that if you have EIT or EUVI observations opened, CORIMP treats these as 2 separate observations for disk and off-limb. So, in principle, you could choose different wavelengths for disk and off-limb! After you have chosen your files for each instrument in turn, the following dialogue will open:



You must choose the **Main instrument** from the dropdown menu. During the batch process, CORIMP will use the observation times of the main instrument to select the observations of the other instruments made closest in time.

You choose the Output format you want. Note that the size and resolution of these output files will be set by the graphical output options in the Output section of CORIMP (see **Output** subsection in section 5). Option 'dat' refers to IDL save files. You can select more than one type of output.

Use **Select image directory** to choose the directory to save the batch image-files.

You can choose to save the files with a frm_0001, frm_0002 sequence of file-names (made sequentially in time). This is useful to make movies. Or you can choose to allow CORIMP to save the files with a longer filename based on the names of the instruments and an average observation time.

Click OK when ready. CORIMP should loop through the files and save the images.

7. Save and restore session

If you need to close CORIMP, you can save your session by clicking **Save session** at the top of the main CORIMP widget. CORIMP will ask you for a file-name. You can then return to that session by clicking on **Restore session** and choosing the appropriate saved session.

Appendix 1—Some details on opening and reading files

CORIMP uses the standard SSW routines to open and read fits files. It first uses routine 'mreadfits' to read the header of any fits file. It uses the header to determine which instrument made the observation. This information is passed to function 'read_image_corimp', which opens and reads the fits files using the appropriate instrument software supplied by SSW. Read_image_corimp then creates an IDL structure containing the image and other useful details. This enables the same consistent structure to be used for all instruments.

New instruments
If you want to enable CORIMP to display other instruments other than those listed in section 1 of this document, you need to add code to the read_image_corimp main case statement. Please contact Huw Morgan for help, or if you succeed in adding extra instruments.

Background and calibration files
CORIMP cannot magically open and read images without the user having set up the SSW environments correctly. CORIMP uses various environments set during the launch of SSW to read in various background and calibration images, essential for making decent pictures. For example, to process a LASCO C2 total brightness images, you must have the correct monthly minimum images in the correct directory. Soon, we hope to adapt CORIMP to enable the user to specify different background images other than those used by default through SSW.

Polarization sequences
For COR1 & 2, LASCO C2 & C3 you can choose to open sets of complete, consistent polarization sequences, whether in main window or batch process mode. CORIMP will check that the sequence supplied is consistent and read the sequence into one polarized brightness image.

Images containing the disk
It is useful to apply different image processing routines to the disk and corona, even if observed by the same instrument. For this reason, CORIMP splits EIT or EUVI observations into two—the disk, and offlimb. Therefore, the user can choose to have different observed wavelengths for disk and corona (for example, disk in 171A, corona in 304A)

Appendix 2—Some details of image processing routines

List of routines currently included

CORIMP currently has the following image processing routines:

none (no processing)
point (point filter, useful to remove spikes)
normalization (normalize values in image to mean of zero, std deviation of 1)
nrgf (normalizing radial graded filter, see Morgan et al 2006 Solar Physics)
nrgf_nopoly (simpler version of NRGF, but more prone to noise errors)
nrgf_point (a slow and cumbersome marriage of nrgf and point filter, but very nice results)
boost_bottom (contrast enhancement of the dimmer regions in an image)
byestars (very effective spike removal, at the expense of losing some fine detail)
madmax (edge enhancement)

Suggested processing for various instruments

COR2, C2 and C3, a 'point' process followed by 'nrgf'.

MLSO MKIII/MKIV and COR1, 'byestars' followed by 'nrgf'.

EIT offlimb, 'point' followed by 'nrgf'.

EIT disk, 'normalization' (or 'nrgf_nopoly' is surprisingly good).

Important note: If you process one part of a multi-instrument image with something like NRGF, it may disappear from your main output image. This is because other parts of the image may be not processed, and have values ranging from zero to thousands, whilst the NRGF processed parts have a mean of zero and standard deviation of one! For this reason, if you process the corona using NRGF, but also want to include a disk image, the disk image should also be normalized, for example, using the 'normalization' routine.

Adding your own routines

It is easy to add your own routines. Take a look at process_image_corimp. Add the name of your routine to the list at the start of process_image_corimp. Your routine will then appear in the processes' dropdown lists of CORIMP. Then add the call to your routine in the main case statement in process_image_corimp. If you need help, or succeed in adding your own routines, please contact Huw Morgan.