hkauxplot

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Abstract

Create a postscript or xterm plot of XMM Auxilary or HK data using pgplot. hkauxplot is typically used to plot HK and Aux data, but is useful as a general plotting package.

1 Instruments/Modes

Instrument	Mode
EPIC	ALL
RGS	ALL
OM	ALL

2 Use

pipeline processing	yes
interactive analysis	yes

3 Description

This task produces plots of selected input periodic housekeeping (HK) data columns as a function of that file's `TIME` column. It also produces plots of selected auxiliary file data columns for selected CCDs as a function of a time value derived from the `FRAME` column of the AUX files for either EPIC or RGS. This `FRAME` column can be converted to real time by this task, which calls the **oal** Frame to onboard time (OBT) conversion subroutine OAL_getPosition (though this is not strictly necessary; y-axis values can be plotted versus Frame Number). This task has the flexibility to accept ANY valid column name for either the x or y-axis and make a simple plot, making it useful as a general plotting package (e.g. it is possible to plot a simple lightcurve by selecting the `TIME` and `COUNTS` columns in a lightcurve FITS file).

When plotting either HK or AUX data, this task allows the plotting of GTI intervals that correspond to the column data plotted. These GTI intervals are plotted underneath each individual plot window so they can be viewed better in context. The GTI plot simply shows which interval of the input data columns values occurred during a Good Time Interval. Also, when plotting either HK or AUX data, this task allows the selection of CCDs and/or GTIs individually. For example: one may plot an RGS1 Auxiliary File `NACCEPTC` and `NREJECTC` columns versus TIME (converted from Frame number) for ONLY

CCDs 1, 2, and 3. Another example would be that one may plot a set of EMOS1 HK data file columns, but only plot GTIs for CCD 3.

The user may select the number of input file columns to plot, whether to plot Good Time Intervals (STDGTInn) with the input data columns (if applicable), the number of points to plot per page, the output device (eg. PS, PDF, GIF, XW, depending on which drivers are available), whether to offset the x-axis start point to zero (if the x-axis value is a TIME), the first and last row of a subinterval of a file to plot, whether to plot a subset of the available CCDs or all of them, and whether to convert Frame Number to time using the OAL conversion functions.

The user can plot as many parameters as he wishes, though if one is plotting many columns, many CCDs, and many points, the output (in MB's) of this task can get large (however, the task will not allow more than 18 plots per page for aesthetic reasons). For example: if one plotted 20 columns of an RGS1 file with 10000 points, and all 9 GTIs, at 600 points per page, this would result in 168 pages. It is also important to note that selecting the parameter "useccds" when running this task has a dual purpose. In the case of HK data, selecting on CCDs will open a separate GTI file and plot below the data columns selected the `STDGTInn` values corresponding to the CCDs selected (e.g. if ccds 1, 2, and 3 are selected, each data column is plotted three times, with each of `STDGTI01`, `STDGTI02` and `STDGTI03` data plotted beneath it). In the case of AUX data, selecting on CCDs will plot ONLY the contribution by the CCDs selected to the total data (i.e. the frames in the AUX file contributed by CCDs selected will be plotted). In addition, if the task is called with the parameter "usegtiset", only the GTI's corresponding to the CCDs selected will be plotted.

Each page will contain a plot, with a common time x-axis, covering the range of points per page selected (the default is 600, or the total number of rows in the file if less than 600). The number of points covered on a single page will be fixed, so that if the number of points extends beyond this, each plot will be extended to multiple pages (e.g. if an input file has 10000 points and 1000 points per page is selected, the task will plot the data on 10 pages. If the number of CCDs/GTIs times the number of columns selected exceeds 18, all the columns and GTIs/CCDs will be plotted for a 1000 point subinterval on multiple pages before starting a new subinterval).

An offset can be selected that converts a `TIME` x-axis column to seconds since the first time bin (the default is the native form of the `TIME` column, ie: seconds from the beginning of the observation), so the x-axis appearing at the bottom of each page will be the raw x-axis value (if non-TIME), the raw TIME (presumably in seconds since `MJDREF`), or an offset TIME (in seconds since `TSTART` from the file OR the value of the first row of the file if `TSTART` is not found as a keyword).

The y-axis will be divided into equal size strips, one for each input parameter plotted on that page. Each strip will have its own y-axis scale, covering the range of values relevant for the parameter being plotted. Besides the range label for each parameter, a title for each strip will be plotted (which will be simply the FITS column name) as well as the units derived from the `TUNIT` column value.

If selected for plotting, the GTIs will appear as an additional strip at the bottom of each individual plot and will correspond exactly to the time range plotted for each column. This GTI strip will simply have the value of 0 or 1 depending on whether a time bin is a GOOD time interval. Contiguous GTI areas will be filled with hatched lines for clarity and will this appear to be histograms whereby if shading appears this region is a "Good Time Interval" and if no shading appears this region is a "Bad Time Interval".

The title of each page of the plot will contain identifying information for the instrument, target, proposal and observation. Each page will also be numbered.

This task is specifically designed for producing the PPS summary plot data products. By default output files will be written in postscript, but the user will have the option of selecting an alternative output device, subject to availability in the package pgplot. It can, however, be used as a general plotting package

because the task simply issues warnings if HK or AUX data or a GTI file and extension are not input, then completes a plot with whatever input (if valid for plotting) IS given.

The user is reminded to set the SAS_ODF environment variable if accessing HK and/or AUX data directly from an ODF.

3.1 Detailed Description

The HK parameter names are defined by the names of the corresponding columns in the tables of the Auxiliary and HK parameter tables of the ODF. The ODF Auxiliary Data files are described in [1]. The HK Data files are described in [2].

4 Parameters

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

Parameter	Mand	Type	Default	Constraints
useodf	no	boolean	yes	yes—no
Look for infile name in SAS_ODF or input filename?				
set	yes	string	none	valid file name
Input ODF format set or full HK or AUX FITS filename.				
useblock	no	boolean	no	yes—no
Use a specific block name or default to block 0 to find x-axis column?				
block	no	string	none	valid extension name
Block name where x-axis column resides.				
xcolumnname	yes	string	TIME	
Column name for x-axis of plot.				
ycolumnnames	yes	string	none	valid column name
Column names for y-axis of plot.				
usegtiset	no	boolean	yes	yes—no
Plot GTIs under each plot?				
gtiset	no	string	none	valid file name
Name of GTI file to plot.				
useccds	no	boolean	yes	yes—no
Plot by CCDs (must select yes if usegtiset is yes)				
selectccds	no	boolean	no	yes—no
Select individual CCDs to plot?				

ccds	no	integer-list	1	valid number(s) less than numberof instrument CCDs

List of individual CCDs to plot.

plotdevice	yes	string	none	valid plotting device

Name of device type for plot output, if appropriate for entered device type.

selectoutfile	no	boolean	yes	yes—no

Plot output to an actual file instead of a device (eg. XW).

outfile	no	string	none	valid file name

Name of file for output of plot.

convertframe	no	boolean	yes	yes—no

Convert FRAME column to TIME using OAL?

offsettime	no	boolean	yes	yes—no

Use first Time column row (or TSTART if found) as offset?

selectrows	no	boolean	yes	yes—no

Select a rowrange to plot?

startrow	no	integer	1	valid number between 1 and nrows of infile

First row of infile to plot?

stoprow	no	integer	nrows	valid number between firstrow and nrows of infile

Last row of infile to plot?

points	no	integer	600	valid number less than total points

Number of points per page to plot.

5 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.

noGTIfile *(error)*
Input GTI file selected, but blank.

AllCCDselectedInvalid *(error)*
Input CCDs selected not valid.

ROWrangeNotValid *(error)*

Row ranges selected invalid.

FRAMErangeNotValid *(error)*
Frame ranges selected invalid.

TIMErangeNotValid *(error)*
Time ranges selected invalid.

InfileGTIfileNotCongruent *(error)*
Infile and GTI time ranges not congruent.

XcolNotFound *(error)*
X-Axis column name selected not in file.

NotFRAMEorOTHER *(error)*
X-axis column name of unknown type.

TypeError *(error)*
Column type not Int or Real.

FrameTypeNotInt *(error)*
X-axis column name FRAME is not Integer column.

UseodfNoAndConvertYes *(error)*
X-axis column name FRAME, useodf=no,
but convertframe=yes.

CannotConvert *(error)*
Cannot convert FRAME to Time without useodf=yes.

XColStringNotTIME *(error)*
String Type not supportable for non TIME column.

NoYcolParams *(error)*
No y-axis columns selected.

NoYcolsToPlot *(error)*
None of y-axis columns selected plottable.

SelectsNotCompatible *(error)*
Cannot select on more than one criteria: ROW—TIME—FRAME .

useccdsNotSelected *(error)*
Useccds not set but file has CCDs.

CCDIDTypeNotInt *(error)*
Column CCDID not type Int.

NoCCDdata *(error)*
No FRAMES were found for ANY selected CCD.

NoDatatypeAttrib *(error)*
GTI file extension does not contain
DATATYPE attribute.

NoStartStopInGTIfile *(error)*
No START or STOP column in GTI file.

invalidDevice *(error)*
Output device invalid.

TooFewPoints *(error)*
Less than 3 points per page, no plot produced.

OutfileExistsNOoverwrite *(error)*
Output file exists and NOCLOBBER set.

LessThanZeroPtPerPg *(warning)*
Less than or zero points per page requested.
corrective action: Default to nrows.

UseccdsNoAndConvertYes *(warning)*
Param useccds=no, convertframe=yes may not be compatible.
corrective action: Attempt plot if possible.

RowNGreaterThanNrows *(warning)*
User selected last row greater than rows in input file.
corrective action: Default to highest row value in file.

MoreThan1000PtPerPg *(warning)*
More than 1000 points per page requested.
corrective action: Issue warning and continue.

MoreThan20Cols *(warning)*
More than 20 plot columns requested.
corrective action: Issue warning and attempt.

Row1LTZero *(warning)*
Selected Start row less than or zero.
corrective action: Issue warning, default to first row.

NoDatatypeAttrib *(warning)*
Input file extension does not contain DATATYPE attribute
corrective action: continue

CCDselectedInvalid *(warning)*
Individual CCD selected invalid.
corrective action: Select only valid CCDs and continue.

YcolNotFound *(warning)*
Individual Column selected not found
corrective action: Select only valid Columns and continue.

StringColNotPlottable *(warning)*
Individual y-axis Column is String
corrective action: ignore and continue.

ColNotPlottable *(warning)*
Individual y-axis Column is not Int or Real
corrective action: ignore and continue.

GTIextNotExist *(warning)*
GTI Extension name selected does not exist.
corrective action: Default to first extention

noTELESCOP *(warning)*
TELESCOP attribute missing in input file.
corrective action: Set to XMM for plot label.

noINSTRUME *(warning)*
INSTRUME attribute missing in input file.
corrective action: Set to NONE for plot label.

noOBJECT *(warning)*
OBJECT attribute missing in input file.
corrective action: Set to No Object Listed for plot label.

noOBS_ID *(warning)*
OBS_ID attribute missing in input file.
corrective action: Set to 0000000000 for plot label.

noEXP_ID *(warning)*
EXP_ID attribute missing in input file.
corrective action: Set to 00000 for plot label.

noDATE-OBS *(warning)*
DATE-OBS attribute missing in input file.
corrective action: Set to 1999-12-15T00:00:00 for plot label.

noDATE-END *(warning)*
DATE-END attribute missing in input file.
corrective action: Set to 1999-12-15T00:00:00 for plot label.

noDURATION *(warning)*
DURATION attribute missing in input file.
corrective action: Set to 0.0 for plot label.

noMJDREF *(warning)*
MJDREF attribute missing in input file.
corrective action: Set to 50812.5972 for plot label.

noTSTART *(warning)*
TSTART attribute missing in input file.
corrective action: Calculate if possible or set to -999.

noTSTOP *(warning)*
TSTOP attribute missing in input file.
corrective action: Calculate if possible or set to -999.

noTSTARTGTI *(warning)*
TSTART attribute missing in GTI file.
corrective action: Calculate if possible or set to -999.

noTSTOPGTI *(warning)*
TSTOP attribute missing in GTI file.
corrective action: Calculate if possible or set to -999.

GTINotWithTimeX *(warning)*
GTIs inappropriate to non-time x-axis in a plot.
corrective action: Plot selected cols, but not GTIs.

DatatypeNotSTDGTI *(warning)*
GTI extension selected not STDGTInn
corrective action: Attempt plot.

NoSTARTSTOPCols *(warning)*
No START or STOP col found in GTI file selected
corrective action: Plot selected cols, but not GTIs.

PlotSpanPages *(warning)*
All plots in an interval will span pages
corrective action: Warn and attempt.

OutfileExistsOverwriting *(warning)*
Output file selected exists and noclobber not set
corrective action: Issue warning and overwrite file.

6 Input Files

1. EPIC MOS HK data (from EPIC MOS Periodic Housekeeping File).
2. EPIC p-n HK data (from EPIC p-n Periodic Housekeeping File).
3. RGS p-n HK data (from RGS p-n Periodic Housekeeping File).
4. OM HK data (from OM Periodic Housekeeping File).
5. OM non-Periodic HK data (from OM non-Periodic Housekeeping File).
6. Spacecraft HK1 data (from Spacecraft Periodic Housekeeping 1 Files).
7. Spacecraft HK2 data (from Spacecraft Periodic Housekeeping 2 Files).
8. EPIC MOS AUX data (from EPIC MOS Auxiliary Housekeeping File).
9. EPIC p-n AUX data (from EPIC p-n Auxiliary Housekeeping File).
10. RGS p-n AUX data (from RGS p-n Auxiliary Housekeeping File).
11. OM AUX data (from OM Auxiliary Housekeeping File).
12. Any FITS file with integer, or real columns.
13. GTI file compatible with input HK or AUX file.

7 Output Files

1. Any valid pgplot device, defaulting to landscape postscript file.

8 Algorithm

```
subroutine hkauxplot

  subroutine getparams      # read the parameters from hkauxplot.par file
  subroutine check_table    # open selected input file and check

  subroutine get_y_cols     # extract selected y-axis columns from infile
   foreach y_column
    fill_y_axis_array
   next

  if (.not. auxfile) then
   if (TIME column) then
    if (string) then
     call ert2seconds      # convert '1999-12-15T12:00:00.000' to obt
     fill x-axix array
    else
     fill x-axis array
    end if
   else
    fill x-axis array
   end if
  else
   if (FRAME column) then
    sort frames by ccd     # segregate columns by frame numbers and CCDID
    fill x-axis array
    if (convert) then
     call oal_frametoObt   # convert frame to time using framecounter_to_OBT
    end if
   else
    fill x-axis array
   end if
  end if

  if (gtiyes) then
   call get_gti              # open GTI file selected, extract GTIs
   equate time and gtitime   # create gti_array, 1 or 0 if 'GTI' or not
  end if

  create_plot_titles       # use keywords from infile for plot labels

  call do_plot

   subroutine do_plot

    open_plot_device
```

```
    Loop:

     start_new_page            # plot_title

     get_sub_interval_x

     do column = 1 , ncolumns

       if (gtiyes) then

        do ccdno = 1 , n_selected_ccds

          plot_panel
          if (gtiyes) then
           plot_gti_panel
           foreach ON_GTI_area
            fill_gti_area
           next
          end if

          if (last_panel) then
           finish_page
           start_new_page
          end if

        end do

       else

        plot_panel
        if (last_panel) then
          finish_page
          start_new_page
        end if

      end do

       if (last_panel) then
         if (points_remain) then
           finish_page
           start_new_page
         end if
       end if

     next
    close_plot
  end subroutine do_plot

end subroutine hkauxplot
```

9 Comments

- It is assumed this task will only plot HK or AUX and GTI data for the PPS processing. It has been made general enough to plot any non- string parameters from any file.
- The task defaults to plotting a TIME column if no value for parameter "xcolumnname" is entered.
- The task defaults to writing a postscript plot, but in principle can accept any pgplot compatible device, which also lends this task to producing interactive plots at some later stage.
- This task supports vertical (portrait) as well as the default landscape plots. This is accomplished by entering the value "/VPS" as the plot device instead of "/PS".

10 Future developments

There may be a need for binning the values as a typical observation of 40ks will either produce many pages or too many points per page to be useful if the number of columns requested is more than about 20. For now, the user may select a start and end row, frame or time and plot only subintervals of a file. It's not clear that binning is practical because the algorithm would be complex for GTIs. It may be useful to run a separate task like evselect to bin the data BEFORE running hkauxplot.

Pgplot currently creates it's own y-axis scales. This may cause viewing problems for large (multiple orders of magnitude) scales. Thus, it may be necessary to allow for logarithmic plots, but this may prove impractical because adding a parameter for all columns axis scale is cumbersome, and an automated solution (e.g. if more than 2 orders of magnitude) may have unintended results, especially for negative numbers.

While this task supports plotting EPIC and OM housekeeping and auxiliary files, it is not currently requested that they do so. Should this functionality be requested, this task can be expanded to accomodate these files in more than just a general case.

At some point the OAL 'long and short column name converter' may be incorporated. This allows users to use more familiar (and easy to remember and understand) proxy values for the the non-explicit column names (e.g. E1290) in the HK files.

There is some ambiguity in plotting first and last rows for an AUX file. This is due to there being nrows in the file, but only a fraction of the rows are for each CCD (approximately evenly distributed among the number of CCDs in the instrument). If selecting startrow and stoprow parameter values, one should be careful to select only the rows for a selected CCD, not ALL rows (e.g. an RGS AUX file has 900 rows total, but each CCD contributes only 100 rows each (for the 9 RGS CCDs), so if one selects startrow=1 and stoprow=800, it's not clear if they want 8/9ths of the rows of the selected CCD plotted or they want the FRAMES of the selected CCD that occur before row 800. Due to the large number of rows typical in AUX files (100000+), row selection may be vital (especially given the large number of actual COLUMNS available), so this issue will be address shortly.

The main purpose of this program is to produce the PPS summary data products. As such, care should be taken to ensure that data is presented in a manner which is most useful to the user. When multiple pages are necessary to display all the data, the range of the x-axis and the GTI strip should be identical for all plots, so that the data can easily be compared between plots.

11 Developers notes

WARNING: it has been discovered that if the range of points on a plot is small compared to the size of the value (e.g. an interval of 3000 seconds from 70000000 to 70003000), pgplot sometimes overflows the values for the axis. The PLOT appears correct, but the x-axis values are written as "*". The default of hkauxplot is to offset the times (offsettime=yes), this subtracting the lowest value (or TSTART if found) from all values in the x-array, and as a fail-safe, this task also forces exponential writing of these values if they are larger than 10000. Later versions of this task will address this problem, but it is felt that the current solution works in most cases.

11.1 CAL usage

None forseen.

11.2 OAL usage

1. OAL_odfInfo
2. OAL_proposalinfo
3. OAL_exposureInfo
4. OAL_selectExposure
5. OAL_selectScope
6. OAL_selectFile
7. OAL_expandFileName
8. OAL_getState
9. OAL_setState
10. OAL_frameCounterToObt
11. OAL_obtToTimeTag
12. OAL_hasAssociatedSet
13. OAL_activeFilter

References

[1] ESA. XMM Interface Control Document: Observation and Slew Data Files (XSCS to SSC) (SciSIM to SOCSIM). Technical Report XMM-SOC-ICD-0004-SSD Issue 2.5, ESA/SSD, June 2000. Found at the URL: `ftp://astro.estec.esa.nl/pub/XMM/documents/odf_icd.ps.gz`.

[2] K. Galloway. XMM technical note: Periodic housekeeping telemetry definition. Technical Report XMM-SOC-TN-0040-SSD 0.2, ESA/SSD, August 5 1999.