orbit

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Abstract

Task to create a FITS timeseries "HK-like" file from the ODF Spacecraft Predicted or Reconstructed (*ROS.ASC) Orbit File.

1   Instruments/Modes

Instrument	Mode
EPIC	ALL
RGS	ALL
OM	ALL

2   Use

pipeline processing	yes
interactive analysis	yes

3   Description

This task makes position information from the XMM ODF available as a FITS format product file. It has been determined that this product would have value for constructing Good Time Intervals (using **tabgtigen**) based on orbit information, for providing XMM positions in the same coordinate system (GSE) as the ACE and WIND satellites for Trend Data construction (and SWCX analysis), and for possibly creating barycentric correction tables. A FITS format file conforming to both established Orbit file conventions and NASA OGIP FITS standards are more useful than the ASCII Orbit file provided in the XMM ODFs.

This task will utilise the OAL_getPosition routine to return the x-y-z components of the position vector in km as well as the x-y-z components of the corresponding velocity vector in km/s, both with respect to the reference Kepler orbit. Both sets of values will be written into a standard OGIP-compliant FITS binary extension table with a TIME column value, derived from a start, stop and sampling interval time, each specified by the user. This task will default to sampling the entire input file with a timestep interval of 60.0 seconds. The OAL interpolates the positions for times outside of an observation, and the user is warned that if such times are outside an ORBIT of a given ODF, the interpolation my fail or take very long periods of time to calculate.

The GEI to GSE coordinate conversion utilizes IDL routines converted to Fortran90 that originated in the Hapgood1992 paper.

Expanding the use of orbit, and taking advantage or the extrapolation routines in the OAL, one can select times that are far outside the range of a given OBSID. However, because of time and memory constraints, the selection is limited to 172800 seconds before the first time in the current OBSID and 172800 seconds after the last time in that OBSID. This solves the issue of taking a very long time or crashing with a seg fault if the user selects times too far away from the current obsid.

3.1 Detailed Description

The ODF Orbit file iis described in [1]. The Periodic Housekeeping data is described in [2]. The GEI to GSE coordinate conversion utilizes (Hapgood, 1992 [**?**])

4 Parameters

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

Parameter	Mand	Type	Default	Constraints
outfile	yes	string	none	valid file name

Output orbit filename in FITS.

selecttimes	no	boolean	no	yes—no

Input starttime and endtimes or use default whole file.

starttime	no	real—string	none	>0.0 s

Start time for interval in any param "TIME" format.

endtime	no	real—string	none	>0.0 s

End time for interval in any param "TIME" format.

timestep	no	real	60.0	>0.0 s

Bin size (in sec) of step through Orbit information.

useobsid	no	boolean	yes	

Write ObsID info to header?

Note: The only param TIME format supported currently is
the "seconds since XMM reference time" mode.

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.

TotalTimeLEzero *(error)*
   End - Start ¡=0.

StarttimeGTEndtime *(error)*
   Starttime entered greater than Endtime entered.

StartLTorbit *(warning)*

   corrective action: Start time entered more than 2d from orbit start

EndGTorbit *(warning)*

   corrective action: End time entered more than 2d from orbit end

StartZero *(warning)*

   corrective action: Start = 0, selecttimes=yes. Default to OBS start

EndZero *(warning)*

   corrective action: End = 0, selecttimes=yes. Default to OBS end

EndDefault *(warning)*

   corrective action: End time entered greater than ODF obs end time

badTimestep *(warning)*
   Default to 60 seconds
   corrective action: Timestep parameter entered less than 0 or
   greater than time in file

6 Input Files

1. None. SAS_ODF must be properly set.

7 Output Files

1. FITS file with single binary extension containing ten columns; TIME in seconds since MJ-DREF, x-y-z GEI position vectors in km, x-y-z GSE position vectors in km and (GEI) x-y-z velocity vectors in km/s.

8   Algorithm

```
subroutine orbit
 read_parameters      # get parameters from param file
 OAL_odfInfo          # get StartTime, EndTime of file

 open_outfile         # open FITS output file
 addTable             # create new table
 foreach column       # create 10 new columns: time, x, y, z, Vx, Vy, Vz
  addColumn
 next

 for start_time to stop_time, step sampling_interval

  OAL_getPosition   # return position and velocity vectors from ODF

  foreach column      # time, x, y, z, Vx, Vy, Vz
   fill_column_temp_pointer
   if (column_temp_pointer(i) not defined)
    column_temp_pointer(i) = HUGE
   end if
   convert_GEI_to_GSE(time,gei_x,gei_y,gei_z,gse_x,gse_y,gse_z)
! gei_x,y,z : celestial x,y,z of XMM in km.
! gse_x,y,z : geo solar ecliptic x,y,z of XMM in km.
! lambda = ecliptic long of sun  (radians)
!    eta = obliquity of ecliptic (radians)
! The Sun's ecliptic longitude (lambda0) can be calculated using the
! series of formulae:
!
!  meanAnom = 357.528 + 35999.050T0 + 0.04107H degrees
!  Lambda = 280.460 + 36000.772T0 + 0.04107H degrees
!  lambda0 = Lambda + (1.915 - 0.0048T0) sinM + 0.020 sin2M
!
! where T0 is the time in Julian centuries from 12:00 UT on 1 January 2000
! to the midnight Universal Time (UT) preceding the time of interest and
! H is the time in hours since that preceding UT midnight. Formulae
! derived from the Almanac for Computers. In the intermediate formulae,
! meanAnom is the Sun's mean anomaly and Lambda its mean longitude.
!
! M = 357.528+35999.050*Tzero+0.04107*UT; Sun's mean anomaly
! L = 280.460+36000.772*Tzero+0.04107*UT; Sun's mean longitude

  next

 next

 OAL_proposalInfo   # get basic info to write as keywords
 write_attributes_to_outfile     # add proposal info as keywords
 release Table      # close FITS extension
 release Set        # close FITS file
 OAL_releaseMemory  # close ODF files
 close_outfile
end subroutine orbit
```

9 Comments

- This task simply converts some of the available Orbit parameters from their current ODF ascii format (as a Spacecraft Reconstructed Orbit File). It is assumed these positional and velocity parameters can be better accessed in FITS for constructing possible GTI's.

- This task also converts the Geocentric Equatorial Inertial (GEI) in km to Geosynchronous Solar Ecliptic (GSE) in km to facilitate the NASA/GSFC Trend Data construction.

- It is not clear the usefulness of the orbit file for barycentric correction but it is clear this file should be presented in a format that maximizes using preexisting software to calculate such values FROM this file.

10 Future developments

Other coordinate system transformations may be added. Other time systems (e.g., YYYY-MM-DDTHH:MM:SS format) may be available for the start and end times when selecttimes=yes.

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.