Appendix D

Data Retrieval

D.1 Reading the FITS Data

This Appendix lists sample headers for each of the *DIRBE* data products provided in FITS format and gives examples of Interactive Data Language (IDL) and FORTRAN programs that can be used to read the files.

A *COBE* analysis software package, coded primarily in IDL, and the *COBE Guest Investigator Software User's Guide* may be obtained via the *COBE* Home Page at `http://www.gsfc.nasa.gov/astro/cobe/cobe_home.html` (click on "*COBE* analysis software" in the General Information section). The package contains data I/O, analysis, and display tools designed specifically to work with the *COBE* data products and is described in detail in the *User's Guide.*

Other software packages capable of reading FITS binary tables are publicly available. The *FITSIO* FORTRAN subroutines developed for this purpose by W. Pence *et al.* at the NASA/GSFC HEASARC are available from `http://heasarc.gsfc.nasa.gov/docs/software/fitsio/fitsio.html`. The *IDL Astronomy User's Library* developed by W. Landsman *et al.* of the NASA/GSFC UIT team has FITS I/O (and many other) capabilities and is available from `http://idlastro.gsfc.nasa.gov/homepage.html`.

D.1.1 FITS Headers for the *DIRBE* Data Products

D.1.1.1 Calibrated Individual Observations

Table D.1-1: Sample FITS headers for the Calibrated Individual Observations Pixel Index files

```
SIMPLE  =                    T / file does conform to FITS standard
BITPIX  =                   32 / number of bits per data pixel
NAXIS   =                    0 / number of data axes
EXTEND  =                    T / FITS dataset may contain extensions
COMMENT   FITS (Flexible Image Transport System) format defined in Astronomy and
COMMENT   Astrophysics Supplement Series v44/p363, v44/p371, v73/p359, v73/p365.
COMMENT   Contact the NASA Science Office of Standards and Technology for the
COMMENT   FITS Definition document #100 and other FITS information.
DATE    = '11/04/97'           / FITS file creation date (dd/mm/yy)
DATE-MAP= '11/07/95'           / Date of original file creation (dd/mm/yy)
ORIGIN  = 'CDAC    '           / Cosmology Data Analysis Center
TELESCOP= 'COBE    '           / Cosmic Background Explorer satellite
INSTRUME= 'DIRBE   '           / COBE instrument [DIRBE, DMR, FIRAS]
OBJECT  = 'DAILY-SKY'          / part of sky given [e.g., ALL-SKY, WEEKLY-SKY,
COMMENT                        /         DAILY-SKY, GAL-SLICE, FACE ...]
```

```
EQUINOX =               2000.0 / equinox of coords in following tables
REFERENC= 'COBE/DIRBE Explanatory Supplement,' /
REFERENC= 'ed. M.G. Hauser, T. Kelsall, D. Leisawitz, and J. Weiland,' /
REFERENC= 'COBE Ref. Pub. No. 97-A (Greenbelt,MD: NASA/GSFC),' /
REFERENC= 'available in electronic form from the NSSDC.' /
COMMENT
COMMENT    COBE specific keywords
DATE-BEG= '11/12/89'           / date of initial data represented (dd/mm/yy)
DATE-END= '11/12/89'           / date of final data represented   (dd/mm/yy)
PIXRESOL=                    9 / Quad tree pixel resolution [6, 9]
COMMENT
COMMENT    DIRBE specific keywords
PRODUCT = 'CIOINDEX_89345'     / Pixel Index to DIRBE CIO, YYDDD=89345
VERSION = 'Pass 3B '           / Version of Data Reduction Software
COMMENT
COMMENT
END

XTENSION= 'BINTABLE'           / Extension type is Binary Table
BITPIX  =                    8 / Binary data
NAXIS   =                    2 / Data are in a table
NAXIS1  =                    8 / Number of 8 bit bytes in each row
NAXIS2  =               171862 / Number of rows
PCOUNT  =                    0 / Number of bytes of data following table
GCOUNT  =                    1 / Group count (always 1 for bintable extensions)
TFIELDS =                    2 / Number of fields (columns) in the table
COMMENT
COMMENT
COMMENT   -------------------------------------------------------------------
COMMENT   *******************************************************************
COMMENT        DIRBE Calibrated Individual Observations: Pixel Index
COMMENT        -------- Cryogenic Mission, day 345 of 1989 ---------
COMMENT
COMMENT        This is the companion pixel index to the DIRBE Calibrated
COMMENT        Individual Observations (CIO) data file for day 345 of 1989.
COMMENT        The pixel index is intended to simplify and expedite data
COMMENT        retrieval for a user-selected subset of pixels in the CIO.
COMMENT        There is one row in the index table for each DIRBE pixel
COMMENT        (resolution 9) observed on this day.  Pixels are listed in
COMMENT        ascending order.  For each pixel, the pixel index table
COMMENT        identifies the LAST row number within the corresponding
COMMENT        CIO table which contains observations for that pixel.
COMMENT   *******************************************************************
COMMENT   -------------------------------------------------------------------
COMMENT   ===================================================================
COMMENT   Coordinate Information (Spatial):
COMMENT   ===================================================================
COMMENT   -------------------------------------------------------------------
COMMENT       DIRBE Pixel number (resolution 9)
TTYPE1  = 'Pixel_no'           / pipeline fieldname = Pixel_no
TUNIT1  = '        '           /
TFORM1  = '1J      '           /
COMMENT   ---------------------------------------------------------------------
COMMENT   ===================================================================
```

```
COMMENT   Pixel Indexing Information:
COMMENT   ==================================================================
COMMENT   ------------------------------------------------------------------
COMMENT        Number of the last row within the corresponding CIO
COMMENT         binary table which contains information for this pixel number.
COMMENT        Row numbers are counted starting at 1.
COMMENT
TTYPE2  = 'LastRow '           / pipeline fieldname = last_data_record
TUNIT2  = '        '           /
TFORM2  = '1J      '           /
COMMENT   -------------------------------------------------------------------
END
```

Table D.1-2: Sample FITS headers for the Calibrated Individual Observations data files

```
SIMPLE  =                    T / file does conform to FITS standard
BITPIX  =                   32 / number of bits per data pixel
NAXIS   =                    0 / number of data axes
EXTEND  =                    T / FITS dataset may contain extensions
COMMENT   FITS (Flexible Image Transport System) format defined in Astronomy and
COMMENT   Astrophysics Supplement Series v44/p363, v44/p371, v73/p359, v73/p365.
COMMENT   Contact the NASA Science Office of Standards and Technology for the
COMMENT   FITS Definition document #100 and other FITS information.
DATE    = '11/04/97'           / FITS file creation date (dd/mm/yy)
DATE-MAP= '11/07/95'           / Date of original file creation (dd/mm/yy)
ORIGIN  = 'CDAC    '           / Cosmology Data Analysis Center
TELESCOP= 'COBE    '           / Cosmic Background Explorer satellite
INSTRUME= 'DIRBE   '           / COBE instrument [DIRBE, DMR, FIRAS]
OBJECT  = 'DAILY-SKY'          / part of sky given [e.g., ALL-SKY, WEEKLY-SKY,
COMMENT                        /         DAILY-SKY, GAL-SLICE, FACE ...]
EQUINOX =               2000.0 / equinox of coords in following tables
REFERENC= 'COBE/DIRBE Explanatory Supplement,' /
REFERENC= 'ed. M.G. Hauser, T. Kelsall, D. Leisawitz, and J. Weiland,' /
REFERENC= 'COBE Ref. Pub. No. 97-A (Greenbelt,MD: NASA/GSFC),' /
REFERENC= 'available in electronic form from the NSSDC.' /
COMMENT
COMMENT          COBE specific keywords
DATE-BEG= '11/12/89'           / date of initial data represented  (dd/mm/yy)
DATE-END= '11/12/89'           / date of final data represented    (dd/mm/yy)
PIXRESOL=                    9 / Quad tree pixel resolution [6, 9]
COMMENT
COMMENT          DIRBE specific keywords
PRODUCT = 'CIO_89345'          / Calibrated Individual Obs. for YYDDD = 89345
VERSION = 'Pass 3B '           / Version of Data Reduction Software
WAVE1   = '1.25 microns'       / nominal wavelength of Band 1
WAVE2   = '2.2  microns'       / nominal wavelength of Band 2
WAVE3   = '3.5  microns'       / nominal wavelength of Band 3
WAVE4   = '4.9  microns'       / nominal wavelength of Band 4
WAVE5   = '12.  microns'       / nominal wavelength of Band 5
WAVE6   = '25.  microns'       / nominal wavelength of Band 6
WAVE7   = '60.  microns'       / nominal wavelength of Band 7
```

```
WAVE8   = '100. microns'       / nominal wavelength of Band 8
WAVE9   = '140. microns'       / nominal wavelength of Band 9
WAVE10  = '240. microns'       / nominal wavelength of Band 10
SOLELONG= 'ALL     '           / all available solar elongations included
APPVEC  = 'SEPARATE'           / data having different approach vectors
COMMENT                        / are not combined during processing
ZLREMOV =                    F / zodiacal foreground removal indicator
COMMENT                        / if 'T(rue)', zodi foreground has been removed
COMMENT                        / if 'F(alse)', observed sky brightness is given
COMMENT
COMMENT
END

XTENSION= 'BINTABLE'           / Extension type is Binary Table
BITPIX  =                    8 / Binary data
NAXIS   =                    2 / Data are in a table
NAXIS1  =                  109 / Number of 8 bit bytes in each row
NAXIS2  =               474064 / Number of rows
PCOUNT  =                    0 / Number of bytes of data following table
GCOUNT  =                    1 / Group count (always 1 for bintable extensions)
TFIELDS =                   33 / Number of fields (columns) in the table
COMMENT
COMMENT
TIMVERSN= 'OGIP/93-003'        / GSFC Office of Guest Investigator Programs
COMMENT                        / (OGIP) memo in which the convention is
COMMENT                        / described
COMMENT         The times reported in this file are International
COMMENT         Atomic Time (TAI) seconds elapsed since
COMMENT         00:00:00 UTC, 1 January 1981.  Time information is
COMMENT         recorded in a manner consistent with the convention specified
COMMENT         in OGIP/93-003 with the understanding that time is counted
COMMENT         in atomic seconds and the origin of time (MJDREF) is quoted
COMMENT         in ephemeris MJD.
TIMESYS = '1981.00 '           / time system (same as IRAS)
MJDREFI =                44605 / Integer portion of ephemeris MJD
COMMENT                        / corresponding to 0h UTC 1 Jan 1981
MJDREFF =        0.00059240741 / Fractional portion of ephemeris MJD
COMMENT                        / corresponding to 0h UTC 1 Jan 1981
TIMEUNIT= 's       '           / unit for TSTART, TSTOP, TIMEZERO = seconds
TSTART  =        282182405.000 / observation start time in TIMESYS system
TSTOP   =        282268804.999 / observation stop time in TIMESYS system
COMMENT
COMMENT
COMMENT   -------------------------------------------------------------------
COMMENT   *******************************************************************
COMMENT          ---- DIRBE Calibrated Individual Observations ---
COMMENT          ------- Cryogenic Mission, day 345 of 1989 ------
COMMENT
COMMENT          Calibrated individual observations (i.e., 1/8th-second
COMMENT          samples) of the sky as measured by each of the 16 DIRBE
COMMENT          detectors during the specified day. Observations
COMMENT          are sorted in order of increasing pixel number.
COMMENT          It is possible to have multiple observations of a pixel
COMMENT          within a day: these multiple observations are listed in
```

```
COMMENT         consecutive rows within the table and are
COMMENT         sorted in order of ascending observation time.
COMMENT         Reconstruction of time-ordered data strings may be
COMMENT         accomplished either through use of the TIME field
COMMENT         or the PREV_OBS/NEXT_OBS fields.
COMMENT         The companion Pixel Index to this day's data
COMMENT         may be used to determine quickly which pixels were
COMMENT         observed on this day and where data for specific pixels
COMMENT         are located within this file.
COMMENT
COMMENT         Although observations are sorted using the DIRBE
COMMENT         (resolution 9) pixel number (PIXEL_NO), the position
COMMENT         of the boresight at the time of observation may be
COMMENT         reconstructed to a precision of ~20 arcsec by using the
COMMENT         additional pointing information provided in fields
COMMENT         PSUBPOS and PSBSBPOS.  See the COBE/DIRBE Explanatory
COMMENT         Supplement description of this product (Chapter 5) for
COMMENT         further details.
COMMENT
COMMENT         Before using the photometric data, the user should examine
COMMENT         the corresponding data quality flags.  Observations
COMMENT         which occurred within the SAA, non-sky-survey mode data,
COMMENT         or time periods during which none of the DIRBE detectors met
COMMENT         quality standards have already been excluded from this product.
COMMENT         However, time periods during which data from some, but not all,
COMMENT         detectors are of low quality are included. In many of
COMMENT         these cases, the low quality detector data have been
COMMENT         replaced with a sentinel value to guard against inadvertent
COMMENT         use.  There are some instances when low quality data have
COMMENT         neither been removed nor sentinelized.  These include:
COMMENT           1) intervals of excess noise for isolated detectors,
COMMENT              such as Band 1b lunar effects, and the occasional
COMMENT              microphonics noted especially in Bands 4 and 7.
COMMENT              The XSNOISE detector flags are included to
COMMENT              indicate affected observations.
COMMENT           2) observations contaminated by stray light from
COMMENT              the Moon or Jupiter.  The MOON2LOS and JUP2LOS
COMMENT              fields can be used to eliminate these data.
COMMENT
COMMENT         Unlike the higher level DIRBE data products
COMMENT         (e.g., the DIRBE Weekly Maps, Calibrated Annual File,
COMMENT         Maps at Solar Elongation Angle = 90 degrees,
COMMENT         Galactic Plane Maps, Annual Average Maps),
COMMENT         the Calibrated Individual Observations product INCLUDES
COMMENT         data from those portions of the sky which contain
COMMENT         Mars, Jupiter, Saturn, Uranus, Neptune, Juno, Vesta, Ceres,
COMMENT         Pallas, or comets Austin, Levy, and Okazaki-Levy-Rudenko.
COMMENT         The JUP2LOS field indicates when Jupiter was visible;
COMMENT         locations of other objects can be computed using an
COMMENT         external ephemeris.
COMMENT
COMMENT         The foreground signal from Zodiacal dust has not been
COMMENT         removed from the observations.
COMMENT   *******************************************************************
```

```
COMMENT   ---------------------------------------------------------------------
COMMENT   =====================================================================
COMMENT   Coordinate Information (Spatial and Temporal):
COMMENT   =====================================================================
COMMENT   ---------------------------------------------------------------------
COMMENT       DIRBE Pixel number (resolution 9)
TTYPE1  = 'Pixel_no'           /  pipeline fieldname = Pixel_no
TUNIT1  = '        '           /
TFORM1  = '1J      '           /
COMMENT   ---------------------------------------------------------------------
COMMENT       Sub-pixel containing the DIRBE line of sight
COMMENT       when the DIRBE pixel specified in
COMMENT       field "Pixel_no" is divided into 256
COMMENT       sub-pixels (16x16 grid) according
COMMENT       to standard quad-sphere rules
COMMENT       Range: [0 - 255]
TTYPE2  = 'PSubPos '           /  pipeline fieldname = Pixel_subpos
TUNIT2  = '        '           /
TFORM2  = '1B      '           /
COMMENT   ---------------------------------------------------------------------
COMMENT       Sub-sub-pixel containing the DIRBE
COMMENT       line of sight when the DIRBE sub-pixel
COMMENT       specified in field "PSubPos"
COMMENT       is divided into 16 "sub-sub-pixels"
COMMENT       (4x4 grid) according to standard
COMMENT       quad-sphere rules.  The sub-sub-
COMMENT       pixel number is stored in the 4
COMMENT       most significant bits.  Bits 0-3
COMMENT       are not used.
COMMENT       Range: [0 - 15]
TTYPE3  = 'PSbSbPos'           /  pipeline fieldname = Pixel_subsubpos
TUNIT3  = '        '           /
TFORM3  = '1B      '           /
TSCAL3  =            0.0625000 /  divide by 16 to access bits 4-7
TZERO3  =                 0.00 /
COMMENT   ---------------------------------------------------------------------
COMMENT   ---------------------------------------------------------------------
COMMENT       Time of observation in International Atomic Time (TAI)
COMMENT        seconds elapsed since 01-JAN-1981:00:00:00.000 UTC.
COMMENT        The reported time corresponds to the midpoint of the
COMMENT        1/8th second sample interval.
TTYPE4  = 'Time    '           / pipeline fieldname = Time
TUNIT4  = 's       '           /
TFORM4  = '1D      '           /
COMMENT   ---------------------------------------------------------------------
COMMENT       Number of the row within this FITS binary table which
COMMENT       contains the next observation in the time-ordered sequence.
COMMENT       Usually the time of the next observation is TIME + 1/8 sec,
COMMENT       but gaps in the time sequence do exist.
COMMENT       Next_obs is set to -1 if the time of the next observation
COMMENT       lies outside the time boundaries defined for this file.
TTYPE5  = 'Next_obs'           /  pipeline fieldname = Next_obs
TUNIT5  = '        '           /
TFORM5  = '1J      '           /
```

```
COMMENT   ----------------------------------------------------------------
COMMENT       Number of the row within this FITS binary table which contains
COMMENT       the previous observation in the time-ordered sequence.
COMMENT       Usually the time of the previous observation is
COMMENT       TIME - 1/8 sec, but gaps in the time sequence do exist.
COMMENT       Prev_obs is set to -1 if the time of the preceding observation
COMMENT       lies outside the time boundaries defined for this file.
TTYPE6  = 'Prev_obs'           /  pipeline fieldname = Prev_obs
TUNIT6  = '        '           /
TFORM6  = '1J      '           /
COMMENT   ----------------------------------------------------------------
COMMENT   ----------------------------------------------------------------
COMMENT   ================================================================
COMMENT   DIRBE Sky Brightness and Polarization Information:
COMMENT   ================================================================
COMMENT   ----------------------------------------------------------------
COMMENT       The following 16 columns tabulate the 1/8th second
COMMENT       photometric samples taken for the each of the 16
COMMENT       DIRBE detectors at the time of observation.
COMMENT       The photometric measurements
COMMENT       are given as spectral intensities, I(nu) in MJy/sr, and
COMMENT       are quoted at the nominal wavelength
COMMENT       for a source with nu*I(nu) = constant  -- i.e.,
COMMENT       a color correction is required if the source
COMMENT       spectrum differs from nu*I(nu) = constant.
COMMENT       Data which have been replaced by flagged (sentinel) values
COMMENT       in processing have values .LE. -16375.
COMMENT
COMMENT       Photometry for band 1, channel A  (1A: 1.25 um, full intensity)
TTYPE7  = 'Phot1A  '           / pipeline fieldname = Photometry(1)
TUNIT7  = 'MJy/sr  '           /
TFORM7  = '1E      '           /
COMMENT       Photometry for band 1, channel B  (1B: 1.25 um, polarized light)
TTYPE8  = 'Phot1B  '           / pipeline fieldname = Photometry(2)
TUNIT8  = 'MJy/sr  '           /
TFORM8  = '1E      '           /
COMMENT       Photometry for band 1, channel C  (1C: 1.25 um, polarized light)
TTYPE9  = 'Phot1C  '           / pipeline fieldname = Photometry(3)
TUNIT9  = 'MJy/sr  '           /
TFORM9  = '1E      '           /
COMMENT       Photometry for band 2, channel A  (2A: 2.2 um, full intensity)
TTYPE10 = 'Phot2A  '           / pipeline fieldname = Photometry(4)
TUNIT10 = 'MJy/sr  '           /
TFORM10 = '1E      '           /
COMMENT       Photometry for band 2, channel B  (2B: 2.2 um, polarized light)
TTYPE11 = 'Phot2B  '           / pipeline fieldname = Photometry(5)
TUNIT11 = 'MJy/sr  '           /
TFORM11 = '1E      '           /
COMMENT       Photometry for band 2, channel C  (2C: 2.2 um, polarized light)
TTYPE12 = 'Phot2C  '           / pipeline fieldname = Photometry(6)
TUNIT12 = 'MJy/sr  '           /
TFORM12 = '1E      '           /
COMMENT       Photometry for band 3, channel A  (3A: 3.5 um, full intensity)
TTYPE13 = 'Phot3A  '           / pipeline fieldname = Photometry(7)
```

```
TUNIT13 = 'MJy/sr  '           /
TFORM13 = '1E      '           /
COMMENT       Photometry for band 3, channel B  (3B: 3.5 um, polarized light)
TTYPE14 = 'Phot3B  '           / pipeline fieldname = Photometry(8)
TUNIT14 = 'MJy/sr  '           /
TFORM14 = '1E      '           /
COMMENT       Photometry for band 3, channel C  (3C: 3.5 um, polarized light)
TTYPE15 = 'Phot3C  '           / pipeline fieldname = Photometry(9)
TUNIT15 = 'MJy/sr  '           /
TFORM15 = '1E      '           /
COMMENT       Photometry for band 4 (4.9 um)
TTYPE16 = 'Phot04  '           / pipeline fieldname = Photometry(10)
TUNIT16 = 'MJy/sr  '           /
TFORM16 = '1E      '           /
COMMENT       Photometry for band 5 (12 um)
TTYPE17 = 'Phot05  '           / pipeline fieldname = Photometry(11)
TUNIT17 = 'MJy/sr  '           /
TFORM17 = '1E      '           /
COMMENT       Photometry for band 6 (25 um)
TTYPE18 = 'Phot06  '           / pipeline fieldname = Photometry(12)
TUNIT18 = 'MJy/sr  '           /
TFORM18 = '1E      '           /
COMMENT       Photometry for band 7 (60 um)
TTYPE19 = 'Phot07  '           / pipeline fieldname = Photometry(13)
TUNIT19 = 'MJy/sr  '           /
TFORM19 = '1E      '           /
COMMENT       Photometry for band 8 (100 um)
TTYPE20 = 'Phot08  '           / pipeline fieldname = Photometry(14)
TUNIT20 = 'MJy/sr  '           /
TFORM20 = '1E      '           /
COMMENT       Photometry for band 9 (140 um)
TTYPE21 = 'Phot09  '           / pipeline fieldname = Photometry(15)
TUNIT21 = 'MJy/sr  '           /
TFORM21 = '1E      '           /
COMMENT       Photometry for band 10 (240 um)
TTYPE22 = 'Phot10  '           / pipeline fieldname = Photometry(16)
TUNIT22 = 'MJy/sr  '           /
TFORM22 = '1E      '           /
COMMENT   --------------------------------------------------------------------
COMMENT   ====================================================================
COMMENT   DIRBE Viewing Geometry and External Influences Information:
COMMENT   ====================================================================
COMMENT   --------------------------------------------------------------------
COMMENT       Angle between DIRBE boresight (or line of sight, LOS) and
COMMENT       spacecraft orbital velocity vector.
COMMENT       Range = [0, 180] degrees
TTYPE23 = 'LOS2VelV'           /  pipeline fieldname = BS_re_Vel
TUNIT23 = 'deg     '           /
TFORM23 = '1I      '           /
TSCAL23 =            0.0109867 /  bin size 360/(2**15 -1) degrees
TZERO23 =           0.00549333 /  offset to bin center in degrees
COMMENT   --------------------------------------------------------------------
COMMENT       Approach Vector
COMMENT        Divides observations into two groups:
```

```
COMMENT        those which are looking in the forward direction of
COMMENT        spacecraft motion, and those which are looking backwards
COMMENT        from the direction of spacecraft motion.
COMMENT        Approach Vector 1 (AV1):
COMMENT            Forward looking, i.e.,    0 .LE. LOS2VelV .LE.  90 deg
COMMENT        Approach Vector 2 (AV2):
COMMENT            Backward looking, i.e.,  90 .LT. LOS2VelV .LE. 180 deg
TTYPE24 = 'ApprVec '           /  pipeline fieldname = Approach_vector
TUNIT24 = '        '           /
TFORM24 = '1B      '           /
COMMENT   ---------------------------------------------------------------------
COMMENT       Attack Vector
COMMENT        A vector whose three components specify the rate of change
COMMENT        (derivative with respect to time) of the DIRBE boresight
COMMENT        unit vector (i.e. the rate of change of the direction
COMMENT        cosines in geocentric ecliptic coordinates).
COMMENT        The Attack Vector is computed from the cross product of
COMMENT        the spacecraft angular velocity vector (which includes both
COMMENT        orbital and spin components) and the boresight.
COMMENT        The Attack Vector points in the DIRBE scan direction
COMMENT        across the sky, and is normal to the leading edge of the
COMMENT        field of view (FOV). The length of this vector gives the
COMMENT        scan rate in radians/sec.
COMMENT       Nominal range for scan rate: .041 - .044 rad/sec
TTYPE25 = 'AttackV '           /  pipeline fieldname = Attack_vector
TUNIT25 = '        '           /
TFORM25 = '3I      '           /
TDIM25  = '(3)     '           /
TSCAL25 =         0.0000305176 /  bin size 1./(2**15) per second
TZERO25 =                 0.00 /  see ExSupp for offset to bin center in /sec
COMMENT   ---------------------------------------------------------------------
COMMENT       Azimuth of the Attack Vector,
COMMENT        computed as a positive or negative rotation angle about
COMMENT        the DIRBE boresight in the plane normal to the boresight
COMMENT        vector (i.e., the plane of the field of view (FOV)).
COMMENT        Azimuth is measured with respect to the fiducial vector
COMMENT        defined by the cross product of the DIRBE spin axis and
COMMENT        boresight vectors, and is positive if the rotation sense
COMMENT        is the same as that of the spacecraft (i.e., azimuth =
COMMENT        +90 deg. points toward the spin axis, following the
COMMENT        right-hand sign convention).
COMMENT       Range = (-180, 180] degrees
COMMENT       Nominal range: [-2,+2] degrees
TTYPE26 = 'AtV_Azim'           /  pipeline fieldname = FOV_Azimuth
TUNIT26 = 'deg     '           /
TFORM26 = '1I      '           /
TSCAL26 =            0.0109867 /  bin size 360/(2**15 -1) degrees
TZERO26 =           0.00549333 /  offset to bin center in degrees
COMMENT   ---------------------------------------------------------------------
COMMENT       Solar elongation of observation,
COMMENT       i.e. angle between the vector from the spacecraft to the
COMMENT       center of the Sun and the DIRBE line of sight (boresight).
COMMENT       Nominal range = [64, 124] degrees
TTYPE27 = 'SolElong'           /  pipeline fieldname = Sun_re_BS (word 1)
```

```
TUNIT27 = 'deg     '           /
TFORM27 = '1I      '           /
TSCAL27 =            0.0109867 /  bin size 360/(2**15 -1) degrees
TZERO27 =           0.00549333 /  offset to bin center in degrees
COMMENT   ------------------------------------------------------------------
COMMENT       Angle between the vector from the spacecraft to the center
COMMENT       of the moon and the DIRBE line of sight (boresight).
COMMENT       Observations for which Moon2LOS .LE. 10 degrees are
COMMENT       potentially contaminated by lunar stray light.
TTYPE28 = 'Moon2LOS'           /  pipeline fieldname = Moon_re_BS (word 1)
TUNIT28 = 'deg     '           /
TFORM28 = '1I      '           /
TSCAL28 =            0.0109867 /  bin size 360/(2**15 -1) degrees
TZERO28 =           0.00549333 /  offset to bin center in degrees
COMMENT   ------------------------------------------------------------------
COMMENT       Azimuth of the Moon
COMMENT        The vector from the spacecraft to the center of the Moon
COMMENT        is projected onto the plane normal to the boresight vector
COMMENT        (i.e., the plane of the field of view (FOV)).
COMMENT        The azimuth of this projected vector is then computed as a
COMMENT        positive or negative rotation angle about the DIRBE boresight.
COMMENT        Azimuth is measured with respect to the fiducial vector
COMMENT        defined by the cross product of the DIRBE spin axis and
COMMENT        boresight vectors, and is positive if the rotation sense
COMMENT        is the same as that of the spacecraft (i.e., azimuth =
COMMENT        +90 deg. points toward the spin axis, following the
COMMENT        right-hand sign convention).  The AtV_Azim field gives
COMMENT        the relationship between the Attack Vector and the
COMMENT        zero azimuth fiducial.
COMMENT     Range = (-180, 180] degrees
TTYPE29 = 'MoonAzim'           /  pipeline fieldname = Moon_re_BS (word 2)
TUNIT29 = 'deg     '           /
TFORM29 = '1I      '           /
TSCAL29 =            0.0109867 /  bin size 360/(2**15 -1) degrees
TZERO29 =           0.00549333 /  offset to bin center in degrees
COMMENT   ------------------------------------------------------------------
COMMENT       Angle between the vector from the spacecraft to the center
COMMENT       of Jupiter and the DIRBE line of sight (boresight).
COMMENT       Observations for which Jup2LOS .LE. 1.5 degrees are
COMMENT       potentially contaminated by stray light from Jupiter.
TTYPE30 = 'Jup2LOS '           /  pipeline fieldname = Jupiter_re_BS (word 1)
TUNIT30 = 'deg     '           /
TFORM30 = '1I      '           /
TSCAL30 =            0.0109867 /  bin size 360/(2**15 -1) degrees
TZERO30 =           0.00549333 /  offset to bin center in degrees
COMMENT   ------------------------------------------------------------------
COMMENT       Radiation Zone flag
COMMENT        Flag indicates if the spacecraft was within the
COMMENT        South Atlantic Anomaly (SAA), North Van Allen Belt (NVAB)
COMMENT        or South Van Allen Belt (SVAB) at the time of observation.
COMMENT        Radiation zone boundaries for the mission were defined
COMMENT        according to the number of radiation hits received as a
COMMENT        function of COBE subsatellite position.  If the subsatellite
COMMENT        position at the time of observation was contained within
```

```
COMMENT        a zone's defined boundaries, then the flag for that zone
COMMENT        is set.  Subsatellite position is updated every
COMMENT        32 seconds.
COMMENT        Observations occurring within the SAA
COMMENT        have already been eliminated; observations made within the
COMMENT        NVAB and SVAB remain in the dataset.
COMMENT          Bit 0 (LSB) = 1 if in NVAB ; 0 if clear of NVAB
COMMENT          Bit 1       = 1 if in SVAB ; 0 if clear of SVAB
COMMENT          Bit 2       = 1 if in SAA  ; 0 if clear of SAA
COMMENT          Bits 3-7 Not Used
TTYPE31 = 'RadZone '           /  pipeline fieldname = Radiation_cont
TUNIT31 = '        '           /
TFORM31 = '1B      '           /
COMMENT   ----------------------------------------------------------------
COMMENT       Excess Noise Flags (per detector)
COMMENT        Flags indicating if exceptionally noisy data were recorded
COMMENT        by any of the 16 detectors during the 32-second
COMMENT        long Major Frame that included this observation.
COMMENT        Detector observations for which the flag is set
COMMENT        are unreliable and should not be used.
COMMENT        The 16-bit field is encoded so that each bit represents one
COMMENT        of the 16 detectors.  Bits are assigned in detector order:
COMMENT        1A,1B,1C,2A,2B,2C,3A,3B,3C,4,5,6,7,8,9,10, where
COMMENT    Bit  0 (least significant bit) = 1 if Detector 1A excessively noisy
COMMENT    ... up through
COMMENT    Bit 15 (most significant bit)  = 1 if Detector 10 excessively noisy
TTYPE32 = 'XSNoise '           /  pipeline fieldname = Glitch_Flags
TUNIT32 = '        '           /
TFORM32 = '1I      '           /
COMMENT   ----------------------------------------------------------------
COMMENT       Orbit and Attitude Flags.
COMMENT        Miscellaneous orbit and attitude
COMMENT        information encoded into a single byte.  The individual
COMMENT        bits are interpreted as follows, where Bit 0 is the
COMMENT        least significant bit:
COMMENT         Flags indicating attitude used
COMMENT           Bit 0 = 1 if non-definitive attitude
COMMENT                 = 0 if definitive attitude used
COMMENT           Bit 1 = 1 if coarse attitude used
COMMENT                 = 0 if fine attitude used
COMMENT           Bit 2 = 1 if merged attitude used
COMMENT                 = 0 if external (UAX) attitude used
COMMENT         Flags describing attitude control
COMMENT           Bit 3 = 1 if spacecraft slewing
COMMENT                 = 0 otherwise
COMMENT           Bit 4 = 1 during Special Pointing
COMMENT                 = 0 otherwise
COMMENT         Node Flag
COMMENT           Bit 5 = 1 when spacecraft (NOT LOS) in ascending
COMMENT                   portion of COBE orbit, i.e., moving
COMMENT                   up towards North Ecliptic Pole
COMMENT                 = 0 when spacecraft (NOT LOS) in descending
COMMENT                   portion of COBE orbit, i.e., moving
COMMENT                   down towards South Ecliptic Pole
```

```
COMMENT         Leading/Trailing Flag
COMMENT           Plane passing through Sun, Earth and ecliptic poles
COMMENT           divides sky into two halves:
COMMENT           Bit 6 = 1 when LOS is pointed to that half of sky
COMMENT                   LEADING earth orbital motion
COMMENT                 = 0 when LOS is pointed to that half of sky
COMMENT                   TRAILING earth orbital motion
COMMENT         Bit 7 Not Used
TTYPE33 = 'OA_Flags'           /  pipeline fieldname = ATT_Flags
TUNIT33 = '        '           /
TFORM33 = '1B      '           /
COMMENT   --------------------------------------------------------------------
END
```

D.1.1.2 *DIRBE* Calibrated Annual File

Table D.1-3: Sample FITS headers for the *DIRBE* Calibrated Annual File Index files

```
SIMPLE  =                    T / file does conform to FITS standard
BITPIX  =                   32 / number of bits per data pixel
NAXIS   =                    0 / number of data axes
EXTEND  =                    T / FITS dataset may contain extensions
COMMENT   FITS (Flexible Image Transport System) format defined in Astronomy and
COMMENT   Astrophysics Supplement Series v44/p363, v44/p371, v73/p359, v73/p365.
COMMENT   Contact the NASA Science Office of Standards and Technology for the
COMMENT   FITS Definition document #100 and other FITS information.
DATE    = '09/04/97'           / FITS file creation date (dd/mm/yy)
DATE-MAP= '04/04/96'           / Date of original file creation (dd/mm/yy)
ORIGIN  = 'CDAC    '           / Cosmology Data Analysis Center
TELESCOP= 'COBE    '           / Cosmic Background Explorer satellite
INSTRUME= 'DIRBE   '           / COBE instrument [DIRBE, DMR, FIRAS]
OBJECT  = 'FACE0   '           / part of sky given [e.g., ALL-SKY, WEEKLY-SKY,
COMMENT                        /         DAILY-SKY, GAL-SLICE, FACE ...]
EQUINOX =               2000.0 / equinox of coords in following tables
REFERENC= 'COBE/DIRBE Explanatory Supplement,' /
REFERENC= 'ed. M.G. Hauser, T. Kelsall, D. Leisawitz, and J. Weiland,' /
REFERENC= 'COBE Ref. Pub. No. 97-A (Greenbelt,MD: NASA/GSFC),' /
REFERENC= 'available in electronic form from the NSSDC.' /
COMMENT
COMMENT     COBE specific keywords
DATE-BEG= '11/12/89'           / date of initial data represented (dd/mm/yy)
DATE-END= '21/09/90'           / date of final data represented   (dd/mm/yy)
PIXRESOL=                    9 / Quad tree pixel resolution [6, 9]
COMMENT
COMMENT     DIRBE specific keywords
PRODUCT = 'DCAFINDEX_F0'       / Pixel Index file for DCAF, Face 0
VERSION = 'Pass 3B '           / Version of Data Reduction Software
COMMENT
COMMENT
END
```

```
XTENSION= 'BINTABLE'           / Extension type is Binary Table
BITPIX  =                    8 / Binary data
NAXIS   =                    2 / Data are in a table
NAXIS1  =                   14 / Number of 8 bit bytes in each row
NAXIS2  =                65536 / Number of rows
PCOUNT  =                    0 / Number of bytes of data following table
GCOUNT  =                    1 / Group count (always 1 for bintable extensions)
TFIELDS =                    3 / Number of fields (columns) in the table
COMMENT
COMMENT
COMMENT   ------------------------------------------------------------------
COMMENT   ******************************************************************
COMMENT          DIRBE Calibrated Annual File, Face 0 : Pixel Index
COMMENT
COMMENT          This is the companion pixel index to the DIRBE
COMMENT          Calibrated Annual File (DCAF) for Face 0 of the COBE
COMMENT          Quadrilateralized Spherical Cube: i.e., the index to DCAF
COMMENT          data tabulated for DIRBE pixel numbers 0 - 65535.
COMMENT          The pixel index is intended to simplify and expedite data
COMMENT          retrieval for a user-selected subset of pixels in the
COMMENT          DCAF.  There is one row in the index table for each DIRBE
COMMENT          pixel (resolution 9) on the cube face.  Pixels are listed
COMMENT          in ascending order.  For each pixel, the pixel index
COMMENT          table gives the number of the LAST row within the
COMMENT          corresponding DCAF table which contains observations for
COMMENT          that pixel, and specifies which mission weeks contain
COMMENT          observations for that pixel.
COMMENT   ******************************************************************
COMMENT   ------------------------------------------------------------------
COMMENT   ==================================================================
COMMENT   Coordinate Information (Spatial):
COMMENT   ==================================================================
COMMENT   ------------------------------------------------------------------
COMMENT       DIRBE Pixel number (resolution 9)
TTYPE1  = 'Pixel_no'           / pipeline fieldname = Pixel_no
TUNIT1  = '        '           /
TFORM1  = '1J      '           /
COMMENT   --------------------------------------------------------------------
COMMENT   ==================================================================
COMMENT   Pixel Indexing Information:
COMMENT   ==================================================================
COMMENT   ------------------------------------------------------------------
COMMENT        Number of the last row within the corresponding DCAF
COMMENT         binary table which contains information for this pixel number.
COMMENT        Row numbers are counted starting at 1.
COMMENT
TTYPE2  = 'LastRow '           /  pipeline fieldname = last_data_record
TUNIT2  = '        '           /
TFORM2  = '1J      '           /
COMMENT   -------------------------------------------------------------------
COMMENT        Mission week numbers for which data are available on this
COMMENT        pixel. Stored as a 6 byte (48 bit) vector, where each bit
COMMENT        corresponds to a specific week number in the mission.
COMMENT        Bit numbers start with 0 as the LSB in byte 1, 8 as the
```

```
COMMENT        LSB in byte 2, etc., and are related to mission week
COMMENT        numbers as follows:
COMMENT           Week number = bit number + 4
COMMENT        Thus, for example, if the LSB in byte 3 is set to 1, then
COMMENT        data are available for mission week 20.  Week numbers range
COMMENT        from 4 to 44.  A list of week numbers and their corresponding
COMMENT        times is provided in the Explanatory Supplement.
COMMENT
TTYPE3  = 'WksObs  '           /  pipeline fieldname = weeks_observed
TUNIT3  = '        '           /
TFORM3  = '6B      '           /
TDIM3   = '(6)     '           /
COMMENT   --------------------------------------------------------------------
END
```

Table D.1-4: Sample FITS headers for the *DIRBE* Calibrated Annual File

```
SIMPLE  =                    T / file does conform to FITS standard
BITPIX  =                   32 / number of bits per data pixel
NAXIS   =                    0 / number of data axes
EXTEND  =                    T / FITS dataset may contain extensions
COMMENT   FITS (Flexible Image Transport System) format defined in Astronomy and
COMMENT   Astrophysics Supplement Series v44/p363, v44/p371, v73/p359, v73/p365.
COMMENT   Contact the NASA Science Office of Standards and Technology for the
COMMENT   FITS Definition document #100 and other FITS information.
DATE    = '09/04/97'           / FITS file creation date (dd/mm/yy)
DATE-MAP= '04/04/96'           / Date of original file creation (dd/mm/yy)
ORIGIN  = 'CDAC    '           / Cosmology Data Analysis Center
TELESCOP= 'COBE    '           / Cosmic Background Explorer satellite
INSTRUME= 'DIRBE   '           / COBE instrument [DIRBE, DMR, FIRAS]
OBJECT  = 'FACE0   '           / part of sky given [e.g., ALL-SKY, WEEKLY-SKY,
COMMENT                        /         DAILY-SKY, GAL-SLICE, FACE ...]
EQUINOX =               2000.0 / equinox of coords in following tables
REFERENC= 'COBE/DIRBE Explanatory Supplement,' /
REFERENC= 'ed. M.G. Hauser, T. Kelsall, D. Leisawitz, and J. Weiland,' /
REFERENC= 'COBE Ref. Pub. No. 97-A (Greenbelt,MD: NASA/GSFC),' /
REFERENC= 'available in electronic form from the NSSDC.' /
COMMENT
COMMENT           COBE specific keywords
DATE-BEG= '11/12/89'           / date of initial data represented  (dd/mm/yy)
DATE-END= '21/09/90'           / date of final data represented    (dd/mm/yy)
PIXRESOL=                    9 / Quad tree pixel resolution [6, 9]
COMMENT
COMMENT           DIRBE specific keywords
PRODUCT = 'DCAF_F0 '           / DIRBE Calibrated Annual File, Face 0
VERSION = 'Pass 3B '           / Version of Data Reduction Software
WAVE1   = '1.25 microns'       / nominal wavelength of Band 1
WAVE2   = '2.2  microns'       / nominal wavelength of Band 2
WAVE3   = '3.5  microns'       / nominal wavelength of Band 3
WAVE4   = '4.9  microns'       / nominal wavelength of Band 4
WAVE5   = '12.  microns'       / nominal wavelength of Band 5
```

```
WAVE6   = '25.  microns'       / nominal wavelength of Band 6
WAVE7   = '60.  microns'       / nominal wavelength of Band 7
WAVE8   = '100. microns'       / nominal wavelength of Band 8
WAVE9   = '140. microns'       / nominal wavelength of Band 9
WAVE10  = '240. microns'       / nominal wavelength of Band 10
SOLELONG= 'ALL     '           / all available solar elongations included
APPVEC  = 'COMBINED'           / data having different approach vectors
COMMENT                        / are combined during processing
ZLREMOV =                    F / zodiacal foreground removal indicator
COMMENT                        / if 'T(rue)', zodi foreground has been removed
COMMENT                        / if 'F(alse)', observed sky brightness is given
COMMENT
COMMENT
END

XTENSION= 'BINTABLE'           / Extension type is Binary Table
BITPIX  =                    8 / Binary data
NAXIS   =                    2 / Data are in a table
NAXIS1  =                  131 / Number of 8 bit bytes in each row
NAXIS2  =              2085580 / Number of rows
PCOUNT  =                    0 / Number of bytes of data following table
GCOUNT  =                    1 / Group count (always 1 for bintable extensions)
TFIELDS =                   15 / Number of fields (columns) in the table
COMMENT
COMMENT
TIMVERSN= 'OGIP/93-003'        / GSFC Office of Guest Investigator Programs
COMMENT                        / (OGIP) memo in which the convention is
COMMENT                        / described
COMMENT         The times reported in this file are International
COMMENT         Atomic Time (TAI) seconds elapsed since
COMMENT         00:00:00 UTC, 1 January 1981.  Time information is
COMMENT         recorded in a manner consistent with the convention specified
COMMENT         in OGIP/93-003 with the understanding that time is counted
COMMENT         in atomic seconds and the origin of time (MJDREF) is quoted
COMMENT         in ephemeris MJD.
TIMESYS = '1981.00 '           / time system (same as IRAS)
MJDREFI =                44605 / Integer portion of ephemeris MJD
COMMENT                        / corresponding to 0h UTC 1 Jan 1981
MJDREFF =        0.00059240741 / Fractional portion of ephemeris MJD
COMMENT                        / corresponding to 0h UTC 1 Jan 1981
TIMEUNIT= 's       '           / unit for TSTART, TSTOP, TIMEZERO = seconds
TSTART  =        282185275.611 / observation start time in TIMESYS system
TSTOP   =        306753235.358 / observation stop time in TIMESYS system
COMMENT
COMMENT
COMMENT   -------------------------------------------------------------------
COMMENT   *******************************************************************
COMMENT              ------ DIRBE Calibrated Annual File: Face 0 -----
COMMENT              --------------- Cryogenic Mission ---------------
COMMENT
COMMENT          The DIRBE Calibrated Annual File (DCAF) combines the
COMMENT          information contained in the 41 DIRBE Weekly Sky Maps
COMMENT          into a merged all-sky version which is sorted by ascending
COMMENT          DIRBE pixel number (resolution 9).  Although the
```

```
COMMENT         information is identical to that given in the complete
COMMENT         set of Weekly Sky Maps for the cryogenic mission, the
COMMENT         data are organized differently, allowing more convenient
COMMENT         access to the full range of temporal variations observed
COMMENT         for each pixel. The DCAF table contains multiple row
COMMENT         entries for each pixel, one row for each mission week for
COMMENT         which photometric data are available. The multiple entries
COMMENT         per pixel are stored in consecutive rows which are
COMMENT         sorted in order of increasing observation time.
COMMENT         A companion Pixel Index is provided to facilitate data
COMMENT         selection and extraction.
COMMENT
COMMENT         Because of its relatively large size, the DCAF has been
COMMENT         divided into six separate data files, each of which has
COMMENT         its own Pixel Index.  Each of the six data files
COMMENT         corresponds to a face on the DIRBE skycube, and each is
COMMENT         named according to the face number.  The face number
COMMENT         is also recorded in the OBJECT and PRODUCT keywords.
COMMENT         There is no overlap in sky coverage between the files.
COMMENT         Sky coverage is as follows:
COMMENT
COMMENT                                         Range(*) of     Range(*) of
COMMENT         Face No.   DIRBE Pixel No.s   Ecl. Longitude  Ecl. Latitude
COMMENT         --------   ----------------   --------------  -------------
COMMENT            0            0 -  65535      0 - 360 deg   +45 to +90 deg
COMMENT            1        65536 - 131071    315 -  45       -45 to +45
COMMENT            2       131072 - 196607     45 - 135       -45 to +45
COMMENT            3       196608 - 262143    135 - 225       -45 to +45
COMMENT            4       262144 - 327679    225 - 315       -45 to +45
COMMENT            5       327680 - 393215      0 - 360       -45 to -90
COMMENT
COMMENT         (*) The ecliptic coordinate ranges are only approximate.
COMMENT         A more complete description of the sky coverage for each
COMMENT         face is provided in the DIRBE Explanatory Supplement,
COMMENT         Chapter 5.
COMMENT
COMMENT         As with the DIRBE Weekly Sky Maps, the as-observed sky
COMMENT         brightness is tabulated; the foreground signal from
COMMENT         Zodiacal dust has not been removed.
COMMENT   ****************************************************************
COMMENT   -----------------------------------------------------------------
COMMENT   =================================================================
COMMENT   Coordinate Information (Spatial and Temporal):
COMMENT   =================================================================
COMMENT   -----------------------------------------------------------------
COMMENT      DIRBE Pixel number (resolution 9)
TTYPE1  = 'Pixel_no'           / pipeline fieldname = Pixel_no
TUNIT1  = '        '           /
TFORM1  = '1J      '           /
COMMENT   ----------------------------------------------------------------
COMMENT     Sub-pixel containing the mean DIRBE LOS (line-of-sight)
COMMENT      when pixel is divided into 256
COMMENT      sub-pixels (16x16 grid) according to
COMMENT      standard quad-sphere rules
```

```
TTYPE2  = 'PSubPos '           / pipeline fieldname = Pixel_subpos
TUNIT2  = '        '           /
TFORM2  = '1B      '           /
COMMENT   --------------------------------------------------------------------
COMMENT     Sub-pixel number of the average line-of-sight
COMMENT      for individual bands which are expected to
COMMENT      have the largest offsets from the nominal position.
COMMENT      Subpixels are specified as a 16x16 grid
COMMENT      according to standard quad-sphere rules.
COMMENT      Byte 1: Sub-pixel for Band 1A
COMMENT      Byte 2: Sub-pixel for Band 4
COMMENT      Byte 3: Sub-pixel for Band 7
COMMENT      Byte 4: Sub-pixel for Band 8
TTYPE3  = 'Displace'           / pipeline fieldname = Displacement_Means
TUNIT3  = '        '           /
TFORM3  = '4B      '           /
TDIM3   = '(4)     '           /
COMMENT   --------------------------------------------------------------------
COMMENT       Time in International Atomic Time (TAI) seconds
COMMENT       elapsed since 01-JAN-1981:00:00:00.000 UTC.
COMMENT       This is the average time of all observations of a pixel
COMMENT       within the time interval TSTART to TSTOP,
COMMENT       regardless of the weight assigned to a particular observation.
TTYPE4  = 'Time    '           / pipeline fieldname = Time
TUNIT4  = 's       '           /
TFORM4  = '1D      '           /
COMMENT   --------------------------------------------------------------------
COMMENT     Difference between the average time of observation of the pixel
COMMENT      for each photometric band, and the
COMMENT      average time of all observations of the pixel (as given in the
COMMENT      TIME field).  Therefore, for each pixel:
COMMENT     Average time of observation of Band x = TIME + (DeltaT for Band x).
COMMENT      Given in the order: 1A,2A,3A,4,5,6,7,8,9,10.
COMMENT      Range = [-7.0,+7.0) days
TTYPE5  = 'DeltaT  '           / pipeline fieldname = Delta_times
TUNIT5  = 's       '           /
TFORM5  = '10B     '           /
TDIM5   = '(10)    '           /
TSCAL5  =               4725.0 / bin size (7*24*60*60)/(2**7) seconds
TZERO5  =            -602437.5 / offset to bin center in secs for unsigned byte
COMMENT   --------------------------------------------------------------------
COMMENT     Mean solar elongation of observation, i.e.
COMMENT      angle between the vector from the spacecraft to the center
COMMENT      of the Sun and the DIRBE line-of-sight,
COMMENT      averaged over all observations of the pixel.
COMMENT      Nominal range = [64,124] degrees
TTYPE6  = 'SolElong'           / pipeline fieldname = Elongation
TUNIT6  = 'deg     '           /
TFORM6  = '1I      '           /
TSCAL6  =            0.0109867 / bin size 360/(2**15 -1) degrees
TZERO6  =           0.00549333 / offset to bin center in degrees
COMMENT   --------------------------------------------------------------------
COMMENT   ====================================================================
COMMENT   DIRBE Sky Brightness and Polarization Information:
```

```
COMMENT   ====================================================================
COMMENT   --------------------------------------------------------------------
COMMENT       Robust average of the week's photometric measurements
COMMENT        for the bands in the following order:
COMMENT        1A,2A,3A,4,5,6,7,8,9,10.  The photometric measurements
COMMENT        are given as spectral intensities, I(nu) in MJy/sr, and
COMMENT        are quoted at the nominal wavelength
COMMENT        for a source with nu*I(nu) = constant  -- i.e.,
COMMENT        a color correction is required if the source
COMMENT        spectrum differs from nu*I(nu) = constant.
COMMENT        Data which have been replaced by flagged values
COMMENT        in processing have values .LE. -16375.
TTYPE7  = 'Photomet'          / pipeline fieldname = Photometry
TUNIT7  = 'MJy/sr  '          /
TFORM7  = '10E     '          /
TDIM7   = '(10)    '          /
COMMENT   --------------------------------------------------------------------
COMMENT   Stokes parameters Q and U for Band 1, Q and U
COMMENT     for Band 2, and Q and U for Band 3.
COMMENT     Range = (-2.0,2.0)
COMMENT     Nominal range = (-1.0,1.0)
COMMENT     Three possible cases arise in
COMMENT     storing the Stokes parameters for each band.
COMMENT     Bits 5 and 6 of the Polarization_quality_flag
COMMENT     field (StokQual) indicate which case applies:
COMMENT     Case 1:
COMMENT      Stokes parameters were calculated for the B and C
COMMENT      channels and the averages over both channels are
COMMENT      stored.
COMMENT     Case 2:
COMMENT      Stokes parameters were calculated for the B channel only.
COMMENT     Case 3:
COMMENT      Stokes parameters were calculated for the C channel only.
COMMENT
COMMENT     Indeterminate quantities are set to a flagged value .LE. -16375.
COMMENT
TTYPE8  = 'Stokes  '          / pipeline fieldname = Polarization
TUNIT8  = '        '          /
TFORM8  = '6E      '          /
TDIM8   = '(6)     '          /
COMMENT   --------------------------------------------------------------------
COMMENT     Number of observations of the pixel for this week
COMMENT      that contained at least one valid photometric measurement.
TTYPE9  = 'NumRecs '          / pipeline fieldname = Num_recs
TUNIT9  = '        '          /
TFORM9  = '1I      '          /
COMMENT   --------------------------------------------------------------------
COMMENT     Number of observations which survived robust averaging
COMMENT      and quality constraints to form the photometric averages
COMMENT      supplied for each band in the 'Photomet' field.
COMMENT      Given in the order: 1A,2A,3A,4,5,6,7,8,9,10.
TTYPE10 = 'WtNumObs'          / pipeline fieldname = Weighted_num_obs
TUNIT10 = '        '          /
TFORM10 = '10B     '          /
```

```
TDIM10  = '(10)    '           /
TSCAL10 =                 0.50 / bin size 0.5
TZERO10 =                  0.0 /
COMMENT   ------------------------------------------------------------------
COMMENT     Standard deviation of the mean, in MJy/sr, for the
COMMENT      10 photometric measures, given in
COMMENT      the following order: 1A,2A,3A,4,5,6,7,8,9,10.
COMMENT
COMMENT     The contents B of the Standard_Deviation fields
COMMENT      are given on a uniform logarithmic scale,
COMMENT      spanning 4 decades, having been calculated
COMMENT      from the standard deviations S (in MJy/sr) as follows:
COMMENT      if  S <= 10**-N              then B = 0
COMMENT      if  10**-N < S < 10**(-N+4)  then B = IFIX((N+log10(S))*254./4.)+1
COMMENT      if  S >= 10**(-N+4)          then B = 255
COMMENT       where the value of N is band-dependent, and given below.
COMMENT
COMMENT     Conversely, the standard deviations
COMMENT      can be reconstructed by:
COMMENT      S <= 10**-N                  if  B = 0
COMMENT      S = 10**(4*(B-0.5)/254. - N) if  1 <= B <= 254
COMMENT      S >= 10**(-N+4)              if  B = 255
COMMENT      (The maximum error on the reconstructed value is 1.8 %)
COMMENT
COMMENT
COMMENT     The values of N are:
COMMENT      Bands 1A, 2A, 3A, 4:  N =  4
COMMENT      Bands 5, 6:           N =  3
COMMENT      Bands 7, 8:           N =  2
COMMENT      Band  9:              N =  0
COMMENT      Band  10:             N =  1
COMMENT
COMMENT      Range of S = [10**-N,10**(-N+4)]
TTYPE11 = 'StdDev  '           / pipeline fieldname = Standard_Deviation
TUNIT11 = 'MJy/sr  '           /
TFORM11 = '10B     '           /
TDIM11  = '(10)    '           /
COMMENT   ------------------------------------------------------------------
COMMENT     Standard deviation of the mean, in dimensionless units,
COMMENT      for Stokes parameters Q and U for Band 1,
COMMENT      Q and U for Band 2, and Q and U for Band 3.
COMMENT
COMMENT     The contents B of the Stokes_Standard_Deviation fields
COMMENT      are given on a uniform logarithmic scale,
COMMENT      spanning 4 decades, having been calculated
COMMENT      from the standard deviations S (dimensionless) as follows:
COMMENT      if  S <= 10**-4              then B = 0
COMMENT      if  10**-4 < S < 1           then B = IFIX((4+log10(S))*254./4.)+1
COMMENT      if  S >= 1                   then B = 255
COMMENT
COMMENT     Conversely, the standard deviations
COMMENT      can be reconstructed by:
COMMENT      S <= 10**-4                  if  B = 0
COMMENT      S = 10**(4*(B-0.5)/254. - 4) if  1 <= B <= 254
```

```
COMMENT      S >= 1                       if  B = 255
COMMENT      (The maximum error on the reconstructed value is 1.8 %)
COMMENT
COMMENT
COMMENT      Range of S = [0.0001,1.0]
TTYPE12 = 'StokesSD'           / pipeline fieldname = Stokes_Standard_Deviation
TUNIT12 = '        '           /
TFORM12 = '6B      '           /
TDIM12  = '(6)     '           /
COMMENT   ---------------------------------------------------------------------
COMMENT      Solar System Objects Flag
COMMENT       A one-byte flag which is used to signal
COMMENT       which solar-system objects' exclusion
COMMENT       zones intersect this pixel during
COMMENT       part or all of the time period
COMMENT       covered by the observations.
COMMENT       Data intersected by an exclusion zone
COMMENT       are not included in the photometric
COMMENT       or polarimetric averages.
COMMENT       If set, bits indicate intersection with
COMMENT       the exclusion zone of the following objects:
COMMENT       (Least significant bit = bit 0)
COMMENT            bit 0 --- Moon
COMMENT            bit 1 --- Mars
COMMENT            bit 2 --- Jupiter
COMMENT            bit 3 --- Saturn
COMMENT            bit 4 --- Uranus
COMMENT            bit 5 --- Neptune
COMMENT            bit 6 --- asteroids and comets
COMMENT            bit 7 --- spare
TTYPE13 = 'SSOFlag '           / pipeline fieldname = Pixel_Quality_Flag, byte 3
TUNIT13 = '        '           /
TFORM13 = '1B      '           /
COMMENT   ---------------------------------------------------------------------
COMMENT       Fraction of Data Used
COMMENT       Three-byte flag indicating the fraction
COMMENT       of available data used in the generation
COMMENT       of the weekly averages.
COMMENT       Byte 1   : Average % of all the
COMMENT                  available data that was used in
COMMENT                  the construction of the averaged
COMMENT                  observations for Bands 1A, 2A, 3A,
COMMENT                  4, 5, 6, 8, 9, and 10
COMMENT                  Range = [0,100%]
COMMENT       Byte 2   : Percent of the available Band 1B data
COMMENT                  that was used.
COMMENT                  Range = [0,100%]
COMMENT       Byte 3   : Percent of the available Band 7 data
COMMENT                  that was used.
COMMENT                  Range = [0,100%]
TTYPE14 = 'FracUsed'           / pipeline fieldname = Pixel_Quality_Flag,byte 4-
TUNIT14 = '        '           /
TFORM14 = '3B      '           /
TDIM14  = '(3)     '           /
```

```
TSCAL14 =               0.392 / bin size 100./(2**8 - 1) %
TZERO14 =                 0.0 /
COMMENT   --------------------------------------------------------------------
COMMENT     Six-byte Flag indicating the quality of
COMMENT     data in each set of polarization ratios ( 1B/1A,
COMMENT     1C/1A...,3C/3A), used to find the Stokes parameters.
COMMENT      If any of bits 0 through 4 are set, then the
COMMENT     values of the Stokes parameters
COMMENT     found from these ratios may be subject to error
COMMENT     beyond the formal uncertainties.
COMMENT      One byte per polarization ratio, given in the order
COMMENT       (1B/1A,1C/1A,2B/2A,2C/2A,3B/3A,3C/3A).
COMMENT      Each bit, if set, is interpreted as follows:
COMMENT      Least Significant Bit = Bit 0
COMMENT      Bit 0: Only one ratio available.
COMMENT      Bit 1: Only two ratios available.
COMMENT      Bit 2: Between 3 and 9 ratios available.
COMMENT      Bit 3: Distribution of data such that the
COMMENT             Robust fitting used to deduce Stokes
COMMENT             parameters failed to converge.
COMMENT      Bit 4: Moon is within 25 degrees of boresight
COMMENT             for at least one of the polarization
COMMENT             ratios.
COMMENT      Bit 5: No ratios for 'C' channel: polarization
COMMENT             found from channel 'B' alone.
COMMENT      Bit 6: No ratios for 'B' channel: polarization
COMMENT             found from channel 'C' alone.
COMMENT      Bit 7: Processing of ratios failed to produce a value
COMMENT             of Q or U, or else set them to flag values.
TTYPE15 = 'StokQual'           / pipeline fieldname = Polarization_Quality_Flag
TUNIT15 = '        '           /
TFORM15 = '6B      '           /
TDIM15  = '(6)     '           /
COMMENT   --------------------------------------------------------------------
END
```

D.1.1.3 Weekly Sky Maps

Table D.1-5: Sample Weekly Sky Map FITS header

```
SIMPLE  =                    T / file does conform to FITS standard
BITPIX  =                   32 / number of bits per data pixel
NAXIS   =                    0 / number of data axes
EXTEND  =                    T / FITS dataset may contain extensions
COMMENT   FITS (Flexible Image Transport System) format defined in Astronomy and
COMMENT   Astrophysics Supplement Series v44/p363, v44/p371, v73/p359, v73/p365.
COMMENT   Contact the NASA Science Office of Standards and Technology for the
COMMENT   FITS Definition document #100 and other FITS information.
DATE    = '11/02/97'           / FITS file creation date (dd/mm/yy)
DATE-MAP= '28/03/96'           / Date of original file creation (dd/mm/yy)
ORIGIN  = 'CDAC    '           / Cosmology Data Analysis Center
```

```
TELESCOP= 'COBE    '           / Cosmic Background Explorer satellite
INSTRUME= 'DIRBE   '           / COBE instrument [DIRBE, DMR, FIRAS]
OBJECT  = 'WEEKLY-SKY'         / part of sky given [e.g., ALL-SKY, WEEKLY-SKY,
COMMENT                        /        DAILY-SKY, GAL-SLICE, FACE ...]
EQUINOX =               2000.0 / equinox of coords in following tables
REFERENC= 'COBE/DIRBE Explanatory Supplement,' /
REFERENC= 'ed. M.G. Hauser, T. Kelsall, D. Leisawitz, and J. Weiland,' /
REFERENC= 'COBE Ref. Pub. No. 97-A (Greenbelt,MD: NASA/GSFC),' /
REFERENC= 'available in electronic form from the NSSDC.' /
COMMENT
COMMENT           COBE specific keywords
DATE-BEG= '11/12/89'           / date of initial data represented  (dd/mm/yy)
DATE-END= '17/12/89'           / date of final data represented    (dd/mm/yy)
PIXRESOL=                    9 / Quad tree pixel resolution [6, 9]
COMMENT
COMMENT           DIRBE specific keywords
PRODUCT = 'WEEKMAP4'           / Weekly Averaged Map for Mission Week 4
VERSION = 'Pass 3B '           / Version of Data Reduction Software
WAVE1   = '1.25 microns'       / nominal wavelength of Band 1
WAVE2   = '2.2  microns'       / nominal wavelength of Band 2
WAVE3   = '3.5  microns'       / nominal wavelength of Band 3
WAVE4   = '4.9  microns'       / nominal wavelength of Band 4
WAVE5   = '12.  microns'       / nominal wavelength of Band 5
WAVE6   = '25.  microns'       / nominal wavelength of Band 6
WAVE7   = '60.  microns'       / nominal wavelength of Band 7
WAVE8   = '100. microns'       / nominal wavelength of Band 8
WAVE9   = '140. microns'       / nominal wavelength of Band 9
WAVE10  = '240. microns'       / nominal wavelength of Band 10
SOLELONG= 'ALL     '           / all available solar elongations included
APPVEC  = 'COMBINED'           / data having different approach vectors
COMMENT                        / are combined during processing
ZLREMOV =                    F / zodiacal foreground removal indicator
COMMENT                        / if 'T(rue)', zodi foreground has been removed
COMMENT                        / if 'F(alse)', observed sky brightness is given
COMMENT
COMMENT
END

XTENSION= 'BINTABLE'           / Extension type is Binary Table
BITPIX  =                    8 / Binary data
NAXIS   =                    2 / Data are in a table
NAXIS1  =                  131 / Number of 8 bit bytes in each row
NAXIS2  =               214125 / Number of rows
PCOUNT  =                    0 / Number of bytes of data following table
GCOUNT  =                    1 / Group count (always 1 for bintable extensions)
TFIELDS =                   15 / Number of fields (columns) in the table
COMMENT
COMMENT
TIMVERSN= 'OGIP/93-003'        / GSFC Ofice of Guest Investigator Programs (OGIP
COMMENT                        / memo in which the convention is described
COMMENT         The times reported in this file are International
COMMENT         Atomic Time (TAI) seconds elapsed since
COMMENT         00:00:00 UTC, 1 January 1981.  Time information is
COMMENT         recorded in a manner consistent with the convention specified
```

```
COMMENT         in OGIP/93-003 with the understanding that time is counted
COMMENT         in atomic seconds and the origin of time (MJDREF) is quoted
COMMENT         in ephemeris MJD.
TIMESYS = '1981.00 '           / time system (same as IRAS)
MJDREFI =                44605 / Integer portion of ephemeris MJD
COMMENT                        / corresponding to 0h UTC 1 Jan 1981
MJDREFF =        0.00059240741 / Fractional portion of ephemeris MJD
COMMENT                        / corresponding to 0h UTC 1 Jan 1981
TIMEUNIT= 's       '           / unit for TSTART, TSTOP, TIMEZERO = seconds
TSTART  =        282185275.611 / observation start time in TIMESYS system
TSTOP   =        282787015.111 / observation stop time in TIMESYS system
COMMENT
COMMENT
COMMENT   ----------------------------------------------------------------
COMMENT   ****************************************************************
COMMENT          Weekly Averaged Sky Map -- Mission Week 4
COMMENT          Photometry, Polarization and ancillary data averaged over
COMMENT          one week's worth of observations, covering the dates
COMMENT          11-Dec-1989 to 17-Dec-1989 (inclusive).
COMMENT          The foreground signal from Zodiacal dust remains in the map.
COMMENT   ****************************************************************
COMMENT   -----------------------------------------------------------------
COMMENT   =================================================================
COMMENT   Coordinate Information (Spatial and Temporal):
COMMENT   =================================================================
COMMENT   -----------------------------------------------------------------
COMMENT       DIRBE Pixel number (resolution 9)
TTYPE1  = 'Pixel_no'           / pipeline fieldname = Pixel_no
TUNIT1  = '        '           /
TFORM1  = '1J      '           /
COMMENT   ----------------------------------------------------------------
COMMENT     Sub-pixel containing the mean DIRBE LOS (line-of-sight)
COMMENT      when pixel is divided into 256
COMMENT      sub-pixels (16x16 grid) according to
COMMENT      standard quad-sphere rules
TTYPE2  = 'PSubPos '           / pipeline fieldname = Pixel_subpos
TUNIT2  = '        '           /
TFORM2  = '1B      '           /
COMMENT   -----------------------------------------------------------------
COMMENT     Sub-pixel number of the average line-of-sight
COMMENT      for individual bands which are expected to
COMMENT      have the largest offsets from the nominal position.
COMMENT      Subpixels are specified as a 16x16 grid
COMMENT      according to standard quad-sphere rules.
COMMENT      Byte 1: Sub-pixel for Band 1A
COMMENT      Byte 2: Sub-pixel for Band 4
COMMENT      Byte 3: Sub-pixel for Band 7
COMMENT      Byte 4: Sub-pixel for Band 8
TTYPE3  = 'Displace'           / pipeline fieldname = Displacement_Means
TUNIT3  = '        '           /
TFORM3  = '4B      '           /
TDIM3   = '(4)     '           /
COMMENT   -----------------------------------------------------------------
COMMENT       Time in International Atomic Time (TAI) seconds
```

```
COMMENT       elapsed since 01-JAN-1981:00:00:00.000 UTC.
COMMENT       This is the average time of all observations of a pixel
COMMENT       within the time interval TSTART to TSTOP,
COMMENT       regardless of the weight assigned to a particular observation.
TTYPE4  = 'Time    '           / pipeline fieldname = Time
TUNIT4  = 's       '           /
TFORM4  = '1D      '           /
COMMENT   ----------------------------------------------------------------
COMMENT     Difference between the average time of observation of the pixel
COMMENT      for each photometric band, and the
COMMENT      average time of all observations of the pixel (as given in the
COMMENT      TIME field).  Therefore, for each pixel:
COMMENT     Average time of observation of Band x = TIME + (DeltaT for Band x).
COMMENT      Given in the order: 1A,2A,3A,4,5,6,7,8,9,10.
COMMENT      Range = [-7.0,+7.0) days
TTYPE5  = 'DeltaT  '           / pipeline fieldname = Delta_times
TUNIT5  = 's       '           /
TFORM5  = '10B     '           /
TDIM5   = '(10)    '           /
TSCAL5  =               4725.0 / bin size (7*24*60*60)/(2**7) seconds
TZERO5  =            -602437.5 / offset to bin center in secs for unsigned byte
COMMENT   ----------------------------------------------------------------
COMMENT     Mean solar elongation of observation, i.e.
COMMENT      angle between the vector from the spacecraft to the center
COMMENT      of the Sun and the DIRBE line-of-sight,
COMMENT      averaged over all observations of the pixel.
COMMENT      Nominal range = [64,124] degrees
TTYPE6  = 'SolElong'           / pipeline fieldname = Elongation
TUNIT6  = 'deg     '           /
TFORM6  = '1I      '           /
TSCAL6  =            0.0109867 / bin size 360/(2**15 -1) degrees
TZERO6  =           0.00549333 / offset to bin center in degrees
COMMENT   ----------------------------------------------------------------
COMMENT   ================================================================
COMMENT   DIRBE Sky Brightness and Polarization Information:
COMMENT   ================================================================
COMMENT   ----------------------------------------------------------------
COMMENT       Robust average of the week's photometric measurements
COMMENT        for the bands in the following order:
COMMENT        1A,2A,3A,4,5,6,7,8,9,10.  The photometric measurements
COMMENT        are given as spectral intensities, I(nu) in MJy/sr, and
COMMENT        are quoted at the nominal wavelength
COMMENT        for a source with nu*I(nu) = constant  -- i.e.,
COMMENT        a color correction is required if the source
COMMENT        spectrum differs from nu*I(nu) = constant.
COMMENT        Data which have been replaced by flagged values
COMMENT        in processing have values .LE. -16375.
TTYPE7  = 'Photomet'           / pipeline fieldname = Photometry
TUNIT7  = 'MJy/sr  '           /
TFORM7  = '10E     '           /
TDIM7   = '(10)    '           /
COMMENT   ----------------------------------------------------------------
COMMENT   Stokes parameters Q and U for Band 1, Q and U
COMMENT     for Band 2, and Q and U for Band 3.
```

```
COMMENT     Range = (-2.0,2.0)
COMMENT     Nominal range = (-1.0,1.0)
COMMENT     Three possible cases arise in
COMMENT     storing the Stokes parameters for each band.
COMMENT     Bits 5 and 6 of the Polarization_quality_flag
COMMENT     field (StokQual) indicate which case applies:
COMMENT     Case 1:
COMMENT      Stokes parameters were calculated for the B and C
COMMENT      channels and the averages over both channels are
COMMENT      stored.
COMMENT     Case 2:
COMMENT      Stokes parameters were calculated for the B channel only.
COMMENT     Case 3:
COMMENT      Stokes parameters were calculated for the C channel only.
COMMENT
COMMENT     Indeterminate quantities are set to a flagged value .LE. -16375.
COMMENT
TTYPE8  = 'Stokes  '           / pipeline fieldname = Polarization
TUNIT8  = '        '           /
TFORM8  = '6E      '           /
TDIM8   = '(6)     '           /
COMMENT   --------------------------------------------------------------------
COMMENT     Number of observations of the pixel for this week
COMMENT      that contained at least one valid photometric measurement.
TTYPE9  = 'NumRecs '           / pipeline fieldname = Num_recs
TUNIT9  = '        '           /
TFORM9  = '1I      '           /
COMMENT   --------------------------------------------------------------------
COMMENT     Number of observations which survived robust averaging
COMMENT      and quality constraints to form the photometric averages
COMMENT      supplied for each band in the 'Photomet' field.
COMMENT      Given in the order: 1A,2A,3A,4,5,6,7,8,9,10.
TTYPE10 = 'WtNumObs'           / pipeline fieldname = Weighted_num_obs
TUNIT10 = '        '           /
TFORM10 = '10B     '           /
TDIM10  = '(10)    '           /
TSCAL10 =                 0.50 / bin size 0.5
TZERO10 =                  0.0 /
COMMENT   --------------------------------------------------------------------
COMMENT     Standard deviation of the mean, in MJy/sr, for the
COMMENT      10 photometric measures, given in
COMMENT      the following order: 1A,2A,3A,4,5,6,7,8,9,10.
COMMENT
COMMENT     The contents B of the Standard_Deviation fields
COMMENT      are given on a uniform logarithmic scale,
COMMENT      spanning 4 decades, having been calculated
COMMENT      from the standard deviations S (in MJy/sr) as follows:
COMMENT      if  S <= 10**-N              then B = 0
COMMENT      if  10**-N < S < 10**(-N+4)  then B = IFIX((N+log10(S))*254./4.)+1
COMMENT      if  S >= 10**(-N+4)          then B = 255
COMMENT       where the value of N is band-dependent, and given below.
COMMENT
COMMENT     Conversely, the standard deviations
COMMENT      can be reconstructed by:
```

```
COMMENT      S <= 10**-N                  if  B = 0
COMMENT      S = 10**(4*(B-0.5)/254. - N) if  1 <= B <= 254
COMMENT      S >= 10**(-N+4)              if  B = 255
COMMENT      (The maximum error on the reconstructed value is 1.8 %)
COMMENT
COMMENT
COMMENT     The values of N are:
COMMENT      Bands 1A, 2A, 3A, 4:  N =  4
COMMENT      Bands 5, 6:           N =  3
COMMENT      Bands 7, 8:           N =  2
COMMENT      Band  9:              N =  0
COMMENT      Band  10:             N =  1
COMMENT
COMMENT      Range of S = [10**-N,10**(-N+4)]
TTYPE11 = 'StdDev  '           / pipeline fieldname = Standard_Deviation
TUNIT11 = 'MJy/sr  '           /
TFORM11 = '10B     '           /
TDIM11  = '(10)    '           /
COMMENT   --------------------------------------------------------------------
COMMENT     Standard deviation of the mean, in dimensionless units,
COMMENT      for Stokes parameters Q and U for Band 1,
COMMENT      Q and U for Band 2, and Q and U for Band 3.
COMMENT
COMMENT     The contents B of the Stokes_Standard_Deviation fields
COMMENT      are given on a uniform logarithmic scale,
COMMENT      spanning 4 decades, having been calculated
COMMENT      from the standard deviations S (dimensionless) as follows:
COMMENT      if  S <= 10**-4              then B = 0
COMMENT      if  10**-4 < S < 1           then B = IFIX((4+log10(S))*254./4.)+1
COMMENT      if  S >= 1                   then B = 255
COMMENT
COMMENT     Conversely, the standard deviations
COMMENT      can be reconstructed by:
COMMENT      S <= 10**-4                  if  B = 0
COMMENT      S = 10**(4*(B-0.5)/254. - 4) if  1 <= B <= 254
COMMENT      S >= 1                       if  B = 255
COMMENT      (The maximum error on the reconstructed value is 1.8 %)
COMMENT
COMMENT
COMMENT      Range of S = [0.0001,1.0]
TTYPE12 = 'StokesSD'           / pipeline fieldname = Stokes_Standard_Deviation
TUNIT12 = '        '           /
TFORM12 = '6B      '           /
TDIM12  = '(6)     '           /
COMMENT   --------------------------------------------------------------------
COMMENT      Solar System Objects Flag
COMMENT       A one-byte flag which is used to signal
COMMENT       which solar-system objects' exclusion
COMMENT       zones intersect this pixel during
COMMENT       part or all of the time period
COMMENT       covered by the observations.
COMMENT       Data intersected by an exclusion zone
COMMENT       are not included in the photometric
COMMENT       or polarimetric averages.
```

```
COMMENT       If set, bits indicate intersection with
COMMENT       the exclusion zone of the following objects:
COMMENT       (Least significant bit = bit 0)
COMMENT            bit 0 --- Moon
COMMENT            bit 1 --- Mars
COMMENT            bit 2 --- Jupiter
COMMENT            bit 3 --- Saturn
COMMENT            bit 4 --- Uranus
COMMENT            bit 5 --- Neptune
COMMENT            bit 6 --- asteroids and comets
COMMENT            bit 7 --- spare
TTYPE13 = 'SSOFlag '           / pipeline fieldname = Pixel_Quality_Flag, byte 3
TUNIT13 = '        '           /
TFORM13 = '1B      '           /
COMMENT   ------------------------------------------------------------------
COMMENT       Fraction of Data Used
COMMENT       Three-byte flag indicating the fraction
COMMENT       of available data used in the generation
COMMENT       of the weekly averages.
COMMENT       Byte 1   : Average % of all the
COMMENT                  available data that was used in
COMMENT                  the construction of the averaged
COMMENT                  observations for Bands 1A, 2A, 3A,
COMMENT                  4, 5, 6, 8, 9, and 10
COMMENT                  Range = [0,100%]
COMMENT       Byte 2   : Percent of the available Band 1B data
COMMENT                  that was used.
COMMENT                  Range = [0,100%]
COMMENT       Byte 3   : Percent of the available Band 7 data
COMMENT                  that was used.
COMMENT                  Range = [0,100%]
TTYPE14 = 'FracUsed'           / pipeline fieldname = Pixel_Quality_Flag,byte 4-
TUNIT14 = '        '           /
TFORM14 = '3B      '           /
TDIM14  = '(3)     '           /
TSCAL14 =                0.392 / bin size 100./(2**8 - 1) %
TZERO14 =                  0.0 /
COMMENT   ------------------------------------------------------------------
COMMENT     Six-byte Flag indicating the quality of
COMMENT     data in each set of polarization ratios ( 1B/1A,
COMMENT     1C/1A...,3C/3A), used to find the Stokes parameters.
COMMENT      If any of bits 0 through 4 are set, then the
COMMENT     values of the Stokes parameters
COMMENT     found from these ratios may be subject to error
COMMENT     beyond the formal uncertainties.
COMMENT      One byte per polarization ratio, given in the order
COMMENT       (1B/1A,1C/1A,2B/2A,2C/2A,3B/3A,3C/3A).
COMMENT      Each bit, if set, is interpreted as follows:
COMMENT      Least Significant Bit = Bit 0
COMMENT      Bit 0: Only one ratio available.
COMMENT      Bit 1: Only two ratios available.
COMMENT      Bit 2: Between 3 and 9 ratios available.
COMMENT      Bit 3: Distribution of data such that the
COMMENT             Robust fitting used to deduce Stokes
```

```
COMMENT             parameters failed to converge.
COMMENT      Bit 4: Moon is within 25 degrees of boresight
COMMENT             for at least one of the polarization
COMMENT             ratios.
COMMENT      Bit 5: No ratios for 'C' channel: polarization
COMMENT             found from channel 'B' alone.
COMMENT      Bit 6: No ratios for 'B' channel: polarization
COMMENT             found from channel 'C' alone.
COMMENT      Bit 7: Processing of ratios failed to produce a value
COMMENT             of Q or U, or else set them to flag values.
TTYPE15 = 'StokQual'           / pipeline fieldname = Polarization_Quality_Flag
TUNIT15 = '        '           /
TFORM15 = '6B      '           /
TDIM15  = '(6)     '           /
COMMENT   --------------------------------------------------------------------
END
```

D.1.1.4 Solar Elongation = 90° Sky Map

Table D.1-6: Sample $\varepsilon = 90°$ Sky Map FITS header

```
SIMPLE  =                    T / file does conform to FITS standard
BITPIX  =                   32 / number of bits per data pixel
NAXIS   =                    0 / number of data axes
EXTEND  =                    T / FITS dataset may contain extensions
COMMENT   FITS (Flexible Image Transport System) format defined in Astronomy and
COMMENT   Astrophysics Supplement Series v44/p363, v44/p371, v73/p359, v73/p365.
COMMENT   Contact the NASA Science Office of Standards and Technology for the
COMMENT   FITS Definition document #100 and other FITS information.
DATE    = '11/02/97'           / FITS file creation date (dd/mm/yy)
DATE-MAP= '04/04/96'           / Date of original file creation (dd/mm/yy)
ORIGIN  = 'CDAC    '           / Cosmology Data Analysis Center
TELESCOP= 'COBE    '           / Cosmic Background Explorer satellite
INSTRUME= 'DIRBE   '           / COBE instrument [DIRBE, DMR, FIRAS]
OBJECT  = 'ALL-SKY '           / part of sky given [e.g., ALL-SKY, WEEKLY-SKY,
COMMENT                        /         DAILY-SKY, GAL-SLICE, FACE ...]
EQUINOX =               2000.0 / equinox of coords in following tables
REFERENC= 'COBE/DIRBE Explanatory Supplement,' /
REFERENC= 'ed. M.G. Hauser, T. Kelsall, D. Leisawitz, and J. Weiland,' /
REFERENC= 'COBE Ref. Pub. No. 97-A (Greenbelt,MD: NASA/GSFC),' /
REFERENC= 'available in electronic form from the NSSDC.' /
COMMENT
COMMENT     COBE specific keywords
DATE-BEG= '08/12/89'           / date of initial data represented (dd/mm/yy)
DATE-END= '25/09/90'           / date of final data represented   (dd/mm/yy)
PIXRESOL=                    9 / Quad tree pixel resolution [6, 9]
COMMENT
COMMENT     DIRBE specific keywords
PRODUCT = 'B1A_E90 '           / Band 1A map for solar elongation = 90 deg.
VERSION = 'Pass 3B '           / Version of Data Reduction Software
WAVE1   = '1.25 microns'       / nominal wavelength of Band 1
```

```
SOLELONG= '90 degrees'          / only solar elongations of 90 deg. represented
APPVEC  = 'COMBINED'            / data having different approach vectors
COMMENT                         / are combined during processing
ZLREMOV =                     F / zodiacal foreground removal indicator
COMMENT                         / if 'T(rue)', zodi foreground has been removed
COMMENT                         / if 'F(alse)', observed sky brightness is given
COMMENT
COMMENT
END

XTENSION= 'BINTABLE'            / Extension type is Binary Table
BITPIX  =                     8 / Binary data
NAXIS   =                     2 / Data are in a table
NAXIS1  =                    21 / Number of 8 bit bytes in each row
NAXIS2  =                616474 / Number of rows
PCOUNT  =                     0 / Number of bytes of data following table
GCOUNT  =                     1 / Group count (always 1 for bintable extensions)
TFIELDS =                     7 / Number of fields (columns) in the table
COMMENT
COMMENT
TIMVERSN= 'OGIP/93-003'         / GSFC Ofice of Guest Investigator Programs (OGIP
COMMENT                         / memo in which the convention is described
COMMENT         The times reported in this file are International
COMMENT         Atomic Time (TAI) seconds elapsed since
COMMENT         00:00:00 UTC, 1 January 1981.  Time information is
COMMENT         recorded in a manner consistent with the convention specified
COMMENT         in OGIP/93-003 with the understanding that time is counted
COMMENT         in atomic seconds and the origin of time (MJDREF) is quoted
COMMENT         in ephemeris MJD.
TIMESYS = '1981.00 '            / time system (same as IRAS)
MJDREFI =                 44605 / Integer portion of ephemeris MJD
COMMENT                         / corresponding to 0h UTC 1 Jan 1981
MJDREFF =         0.00059240741 / Fractional portion of ephemeris MJD
COMMENT                         / corresponding to 0h UTC 1 Jan 1981
TIMEUNIT= 's       '            / unit for TSTART, TSTOP, TIMEZERO = seconds
TSTART  =         282007138.349 / observation start time in TIMESYS system
TSTOP   =         307119590.188 / observation stop time in TIMESYS system
COMMENT
COMMENT
COMMENT   -------------------------------------------------------------------
COMMENT   *******************************************************************
COMMENT     Sky Map Interpolated to Solar Elongation=90 deg -- 1.25 microns
COMMENT           Photometric data for Band 1A (1.25 microns) interpolated
COMMENT           to a fixed solar elongation of 90 degrees using
COMMENT           Weekly-Averaged Sky Maps as the basis for the
COMMENT           interpolation.
COMMENT           This map represents the sky as it would be
COMMENT           observed at an elongation of 90 deg.; i.e., signal from
COMMENT           the interplanetary dust cloud has not been removed.
COMMENT           Since the data represented here cover a time range
COMMENT           of 10 months, it is possible for a pixel to have
COMMENT           more than one entry.
COMMENT
COMMENT
```

```
COMMENT   *******************************************************************
COMMENT   -------------------------------------------------------------------
COMMENT   ===================================================================
COMMENT   Coordinate Information (Spatial and Temporal):
COMMENT   ===================================================================
COMMENT   -------------------------------------------------------------------
COMMENT       DIRBE Pixel number  (resolution 9)
TTYPE1  = 'Pixel_no'           / pipeline fieldname = Pixel_no
TUNIT1  = '        '           /
TFORM1  = '1J      '           /
COMMENT   -------------------------------------------------------------------
COMMENT       Time in International Atomic Time (TAI) seconds elapsed
COMMENT       since 01-JAN-1981:00:00:00.000 UTC.
COMMENT        Computed time corresponding to observation of pixel
COMMENT        at solar elongation = 90 deg.
COMMENT        Note that some of the quoted times fall outside of the
COMMENT        boundaries during which actual observations were made.  This
COMMENT        is because extrapolations have been permitted under a limited
COMMENT        set of circumstances, as indicated by the Fit Quality
COMMENT        Flag (FitQual).
TTYPE2  = 'Time    '           / pipeline fieldname = Time
TUNIT2  = 's       '           /
TFORM2  = '1D      '           /
COMMENT   -------------------------------------------------------------------
COMMENT   ===================================================================
COMMENT   DIRBE Sky Brightness Information:
COMMENT   ===================================================================
COMMENT   -------------------------------------------------------------------
COMMENT       Photometry for Band 1A, interpolated to solar elongation 90 deg.
COMMENT        The photometric measurements are given as
COMMENT        spectral intensities, I(nu) in MJy/sr, and
COMMENT        are quoted at the nominal wavelength
COMMENT        for a source with nu*I(nu) = constant  -- i.e.,
COMMENT        a color correction is required if the source
COMMENT        spectrum differs from nu*I(nu) = constant.
COMMENT        Data which have been replaced by flagged values
COMMENT        in processing have values .LE. -16375.
TTYPE3  = 'Photomet'           / pipeline fieldname = Photometry
TUNIT3  = 'MJy/sr  '           / MegaJanskys/steradian
TFORM3  = '1E      '           /
COMMENT   -------------------------------------------------------------------
COMMENT       Effective number of observations of the
COMMENT        pixel over the mission.  This is an approximate
COMMENT        number, calculated from the average of the weekly
COMMENT        weighted numbers of observations for all detectors.
TTYPE4  = 'EfNumObs'           / pipeline fieldname = Effective_num_obs
TUNIT4  = '        '           /
TFORM4  = '1I      '           /
COMMENT   -------------------------------------------------------------------
COMMENT      Standard Deviation
COMMENT       Relative or absolute standard deviation
COMMENT       of the interpolated/extrapolated
COMMENT       photometry, given in logarithmic bins.
COMMENT       Units = none   (Bands 1 - 8)
```

```
COMMENT            = MJy/sr (Bands 9 and 10)
COMMENT      Range = [0,255]
COMMENT     The contents B of the Standard_Deviation
COMMENT     byte have been found from the relative
COMMENT     standard deviations R = sigma(I)/ABS(I) (Bands
COMMENT     1 through 8) or absolute standard deviations R
COMMENT     (Bands 9 and 10) as follows:
COMMENT               N = 3: Bands 1 - 4, 7 and 8
COMMENT               N = 4: Bands 5 and 6
COMMENT               N = 1: Bands 9 and 10
COMMENT
COMMENT     if R <= 10**-N               then B = 0
COMMENT     if 10**-N < R < 10**(-N+4)  then B = IFIX((N+log10(R))*254./4.)+1
COMMENT     if R >= 10**(-N+4)          then B = 255
COMMENT
COMMENT     Conversely, the standard deviations can be reconstructed by:
COMMENT     R <= 10**-N                   if  B = 0
COMMENT     R = 10**(4*(B-0.5)/254. - N) if  1 <= B <= 254
COMMENT     R >= 10**(-N+4)               if  B = 255
COMMENT
COMMENT     StdDev = R * ABS(I)  (Bands 1 - 8)
COMMENT     StdDev = R           (Bands 9, 10)
COMMENT     (The maximum error on the reconstructed value is 1.8 %)
COMMENT
TTYPE5  = 'StdDev  '           / pipeline fieldname = Standard_Deviation
TUNIT5  = '        '           /
TFORM5  = '1B      '           /
COMMENT   -------------------------------------------------------------------
COMMENT      Fit Quality Flag
COMMENT       quality of interpolation to elongation = 90 deg.
COMMENT       Bit 0 = least significant bit
COMMENT
COMMENT       Bits 0-3: Indicator for solar system
COMMENT                 object effects and interpolation
COMMENT                 quality
COMMENT        0000:  No special problems
COMMENT        0001:  One or more weekly average(s)
COMMENT               had data removed due to solar
COMMENT               system object contamination.
COMMENT        0010:  Only two points (weekly averages)
COMMENT               available for the interpolation. Expect
COMMENT               systematic error.
COMMENT        0100:  Average value used rather than interpolated
COMMENT               value, for quality reasons.
COMMENT        1111:  Interpolation impossible.  Intensity set to
COMMENT               a flagged value (.LE. -16375.)
COMMENT
COMMENT       Bits 4-7: Interpolation type indicator:
COMMENT        0000:  Interpolation
COMMENT        0001:  Extrapolation from observations
COMMENT               which have elongations > 90 deg.
COMMENT        0010:  Extrapolation from observations
COMMENT               which have elongations < 90 deg.
COMMENT        0100:  One weekly average was flagged
```

```
COMMENT                as an outlier and not used in
COMMENT                the interpolation process.
COMMENT
TTYPE6  = 'FitQual '           / pipeline fieldname = Interpolation_flag, Byte 1
TUNIT6  = '        '           /
TFORM6  = '1B      '           /
COMMENT   -------------------------------------------------------------------
COMMENT       Fit Chi-squared per degree of freedom
COMMENT        Chi-squared per degree of freedom
COMMENT        for the fit used in the interpolation.
TTYPE7  = 'FitChiSq'           / pipeline fieldname = Interpolation_flag, Byte 2
TUNIT7  = '        '           /
TFORM7  = '1B      '           /
TSCAL7  =                 0.10 / bin size 0.1
TZERO7  =                  0.0 /
COMMENT   -------------------------------------------------------------------
END
```

D.1.1.5 Galactic Plane Maps

Table D.1-7: The Galactic Plane Maps FITS header

```
SIMPLE  =                    T / file does conform to FITS standard
BITPIX  =                   32 / number of bits per data pixel
NAXIS   =                    0 / number of data axes
EXTEND  =                    T / FITS dataset may contain extensions
COMMENT   FITS (Flexible Image Transport System) format defined in Astronomy and
COMMENT   Astrophysics Supplement Series v44/p363, v44/p371, v73/p359, v73/p365.
COMMENT   Contact the NASA Science Office of Standards and Technology for the
COMMENT   FITS Definition document #100 and other FITS information.
DATE    = '11/02/97'           / FITS file creation date (dd/mm/yy)
DATE-MAP= '29/08/96'           / Date of original data file creation (dd/mm/yy)
ORIGIN  = 'CDAC    '           / Cosmology Data Analysis Center
TELESCOP= 'COBE    '           / Cosmic Background Explorer satellite
INSTRUME= 'DIRBE   '           / COBE instrument [DIRBE, DMR, FIRAS]
OBJECT  = 'GAL-SLICE'          / part of sky given [e.g., ALL-SKY, WEEKLY-SKY,
COMMENT                        /         DAILY-SKY, GAL-SLICE, FACE ...]
EQUINOX =               2000.0 / equinox of coords in following tables
REFERENC= 'COBE/DIRBE Explanatory Supplement,' /
REFERENC= 'ed. M.G. Hauser, T. Kelsall, D. Leisawitz, and J. Weiland,' /
REFERENC= 'COBE Ref. Pub. No. 97-A (Greenbelt,MD: NASA/GSFC),' /
REFERENC= 'available in electronic form from the NSSDC.' /
COMMENT
COMMENT
COMMENT        COBE specific keywords
DATE-BEG= '01/01/90'           / date of initial data represented (dd/mm/yy)
DATE-END= '02/07/90'           / date of final data represented   (dd/mm/yy)
PIXRESOL=                    9 / Quad tree pixel resolution   [6, 9]
COMMENT
COMMENT
COMMENT        DIRBE specific keywords
PRODUCT = 'GPM     '           / Galactic Plane Maps
```

```
VERSION = 'Pass 3B '           / Version of Data Reduction Software
WAVE1   = '1.25 microns'       / nominal wavelength of Band 1
WAVE2   = '2.2  microns'       / nominal wavelength of Band 2
WAVE3   = '3.5  microns'       / nominal wavelength of Band 3
WAVE4   = '4.9  microns'       / nominal wavelength of Band 4
WAVE5   = '12.  microns'       / nominal wavelength of Band 5
WAVE6   = '25.  microns'       / nominal wavelength of Band 6
WAVE7   = '60.  microns'       / nominal wavelength of Band 7
WAVE8   = '100. microns'       / nominal wavelength of Band 8
WAVE9   = '140. microns'       / nominal wavelength of Band 9
WAVE10  = '240. microns'       / nominal wavelength of Band 10
SOLELONG= '90 degrees'         / only solar elongations of 90 deg. represented
APPVEC  = 'COMBINED'           / data having different approach vectors
COMMENT                        / are combined during processing
ZLREMOV =                    F / zodiacal foreground removal indicator
COMMENT                        / if 'T(rue)', zodi foreground has been removed
COMMENT                        / if 'F(alse)', observed sky brightness is given
COMMENT
COMMENT
COMMENT
COMMENT
END

XTENSION= 'BINTABLE'           / Extension type is Binary Table
BITPIX  =                    8 / Binary data
NAXIS   =                    2 / Data are in a table
NAXIS1  =                   80 / Number of 8 bit bytes in each row
NAXIS2  =                73644 / Number of rows
PCOUNT  =                    0 / Number of bytes of data following table
GCOUNT  =                    1 / Group count (always 1 for bintable extensions)
TFIELDS =                    8 / Number of fields (columns) in the table
COMMENT
TIMVERSN= 'OGIP/93-003'        / GSFC Ofice of Guest Investigator Programs (OGIP
COMMENT                        / memo in which the convention is described
COMMENT         The times reported in this file are International
COMMENT         Atomic Time (TAI) seconds elapsed since
COMMENT         00:00:00 UTC, 1 January 1981.  Time information is
COMMENT         recorded in a manner consistent with the convention specified
COMMENT         in OGIP/93-003 with the understanding that time is counted
COMMENT         in atomic seconds and the origin of time (MJDREF) is quoted
COMMENT         in ephemeris MJD.
TIMESYS = '1981.00 '           / time system (same as IRAS)
MJDREFI =                44605 / Integer portion of ephemeris MJD
COMMENT                        / corresponding to 0h UTC 1 Jan 1981
MJDREFF =        0.00059240741 / Fractional portion of ephemeris MJD
COMMENT                        / corresponding to 0h UTC 1 Jan 1981
TIMEUNIT= 's       '           / unit for TSTART, TSTOP, TIMEZERO = seconds
TSTART  =        283996977.572 / observation start time in TIMESYS system
TSTOP   =        299759964.990 / observation stop time in TIMESYS system
COMMENT
COMMENT
COMMENT   -------------------------------------------------------------------
COMMENT   *******************************************************************
COMMENT       Galactic-Plane Sky Maps --
```

```
COMMENT      Photometric data for 10 bands (1.25 - 240 microns),
COMMENT      interpolated to a fixed solar elongation of 90 degrees
COMMENT      using Weekly-averaged sky maps as the basis for the
COMMENT      interpolation.
COMMENT      Array contains data only for pixels whose Galactic
COMMENT      coordinates satisfy the conditions:
COMMENT         -10 < b < +10 deg for 30 < l < 330 deg
COMMENT         -15 < b < +15 deg for 330 < l < 360  and 0 < l < 30 deg
COMMENT   ***************************************************************
COMMENT   ---------------------------------------------------------------
COMMENT      DIRBE Pixel number (resolution 9)
TTYPE1  = 'Pixel_no'           / pipeline fieldname = Pixel_no
TUNIT1  = '        '           /
TFORM1  = '1J      '           /
COMMENT   ---------------------------------------------------------------
COMMENT      Photometry
COMMENT       10 intensities,in increasing band number
COMMENT       order (1A,2A,3A,4,5,6,7,8,9,10),
COMMENT       interpolated to solar elongation 90 deg.
COMMENT       The photometric measurements are given as
COMMENT       spectral intensities, I(nu) in MJy/sr, and
COMMENT       are quoted at the nominal wavelength
COMMENT       for a source with nu*I(nu) = constant  -- i.e.,
COMMENT       a color correction is required if the source
COMMENT       spectrum differs from nu*I(nu) = constant.
COMMENT       Data which have been replaced by flagged values
COMMENT       in processing have values .LE. -16375.
TTYPE2  = 'Photomet'           / pipeline fieldname = Photometry
TUNIT2  = 'MJy/sr  '           / MegaJanskys/steradian
TFORM2  = '10E     '           /
TDIM2   = '(10)    '           /
COMMENT   ---------------------------------------------------------------
COMMENT      Data quality flag
COMMENT       Indicates quality of interpolation to elongation = 90 deg.
COMMENT       for each photometric measure.
COMMENT       Listed in increasing band number order: (1A,2A,3A,4,5,6,7,8,9,10)
COMMENT
COMMENT
COMMENT      Byte 1 (least significant byte):
COMMENT      Bit 0 = least significant bit
COMMENT      Bits 0-3: Indicator for input data
COMMENT             quality and interpolation quality:
COMMENT       0001:  One or more weekly average(s)
COMMENT              had some data removed due to solar
COMMENT              system object contamination.
COMMENT       0010:  Only two points (weekly averages)
COMMENT              available for the interpolation. Expect
COMMENT              systematic error.
COMMENT       0100:  Average value used rather than interpolated
COMMENT              value, for quality reasons.
COMMENT       1111:  Interpolation impossible.  Photometry set
COMMENT              to a flagged value (.LE. -16375.)
COMMENT
COMMENT
```

```
COMMENT       Bits 4-7: Interpolation type indicator:
COMMENT        0000:  Interpolation
COMMENT        0001:  Extrapolation from above
COMMENT               ( > specified elongation)
COMMENT        0010:  Extrapolation from below
COMMENT               ( < specified elongation)
COMMENT        0100:  One weekly average was flagged
COMMENT               as an outlier and not used in
COMMENT               the interpolation process.
COMMENT
COMMENT
COMMENT       Byte 2 (most significant byte):
COMMENT       Relative or absolute standard deviation
COMMENT        on the interpolated/extrapolated
COMMENT        intensity for each band, given in
COMMENT        logarithmic binning.
COMMENT          Units = none   (Bands 1 - 8)
COMMENT                = MJy/sr (Bands 9 and 10)
COMMENT          Range = [0,255]
COMMENT        The byte value B has been found from the
COMMENT        RELATIVE standard deviation R = sigma(I)/ABS(I) (Bands 1 to 8)
COMMENT        or ABSOLUTE standard deviation R = sigma(I)     (Bands 9 and 10)
COMMENT        as follows:
COMMENT                N = 3: Bands 1 - 4, 7 and 8
COMMENT                N = 4: Bands 5 and 6
COMMENT                N = 1: Bands 9 and 10
COMMENT
COMMENT        if R <= 10**-N             then B = 0
COMMENT        if 10**-N < R < 10**(-N+4) then B = IFIX((N+log10(R))*254./4.)+1
COMMENT        if R >= 10**(-N+4)         then B = 255
COMMENT
COMMENT
COMMENT        Conversely, the sigma value can be reconstructed by:
COMMENT        R <= 10**-N                   if  B = 0
COMMENT        R  = 10**(4*(B-0.5)/254. - N) if  1 <= B <= 254
COMMENT        R >= 10**(-N+4)               if  B = 255
COMMENT
COMMENT
COMMENT        sigma = R * ABS(I)   (Bands 1 - 8)
COMMENT        sigma = R            (Bands 9 and 10)
COMMENT        (The maximum error on the reconstructed value is 1.8 %)
TTYPE3  = 'PhotQual'           / pipeline fieldname = Phot_quality
TUNIT3  = '        '           /
TFORM3  = '10I     '           /
TDIM3   = '(10)    '           /
COMMENT   ------------------------------------------------------------------
COMMENT       Time in International Atomic Time (TAI) seconds
COMMENT        elapsed since 1-JAN-1981:00:00:00.000 UTC.
COMMENT        Computed time corresponding to observation
COMMENT        of pixel at solar elongation = 90 deg.
TTYPE4  = 'TIME    '           / pipeline fieldname = Time
TUNIT4  = 's       '           /
TFORM4  = '1D      '           /
COMMENT   ------------------------------------------------------------------
```

```
COMMENT       Ecliptic longitude of pixel center
COMMENT         range = [0,360) degrees
TTYPE5  = 'EcLon   '           / pipeline fieldname = Ecliptic_longitude
TUNIT5  = 'deg     '           /
TFORM5  = '1I      '           /
TSCAL5  =            0.0109867 / bin size 360/(2**15-1) degrees
TZERO5  =           0.00549333 / offset to bin center in degrees
COMMENT   -------------------------------------------------------------------
COMMENT       Ecliptic latitude of pixel center
COMMENT         range = [-90, 90] degrees
TTYPE6  = 'EcLat   '           / pipeline fieldname = Ecliptic_latitude
TUNIT6  = 'deg     '           /
TFORM6  = '1I      '           /
TSCAL6  =            0.0109867 / bin size 360/(2**15-1) degrees
TZERO6  =           0.00549333 / offset to bin center in degrees
COMMENT   -------------------------------------------------------------------
COMMENT       Galactic longitude of pixel center
COMMENT         range = [0,360) degrees
TTYPE7  = 'GaLon   '           / pipeline fieldname = Galactic_longitude
TUNIT7  = 'deg     '           /
TFORM7  = '1I      '           /
TSCAL7  =            0.0109867 / bin size 360/(2**15-1) degrees
TZERO7  =           0.00549333 / offset to bin center in degrees
COMMENT   -------------------------------------------------------------------
COMMENT       Galactic latitude of pixel center
COMMENT         range = [-90, 90] degrees
TTYPE8  = 'GaLat   '           / pipeline fieldname = Galactic_latitude
TUNIT8  = 'deg     '           /
TFORM8  = '1I      '           /
TSCAL8  =            0.0109867 / bin size 360/(2**15-1) degrees
TZERO8  =           0.00549333 / offset to bin center in degrees
COMMENT   -------------------------------------------------------------------
END
```

D.1.1.6 Annual Average Sky Maps

Table D.1-8: Sample Annual Average Sky Map FITS header

```
SIMPLE  =                    T / file does conform to FITS standard
BITPIX  =                   32 / number of bits per data pixel
NAXIS   =                    0 / number of data axes
EXTEND  =                    T / FITS dataset may contain extensions
COMMENT   FITS (Flexible Image Transport System) format defined in Astronomy and
COMMENT   Astrophysics Supplement Series v44/p363, v44/p371, v73/p359, v73/p365.
COMMENT   Contact the NASA Science Office of Standards and Technology for the
COMMENT   FITS Definition document #100 and other FITS information.
DATE    = '11/02/97'           / FITS file creation date (dd/mm/yy)
DATE-MAP= '04/04/96'           / Date of original file creation (dd/mm/yy)
ORIGIN  = 'CDAC    '           / Cosmology Data Analysis Center
TELESCOP= 'COBE    '           / Cosmic Background Explorer satellite
INSTRUME= 'DIRBE   '           / COBE instrument [DIRBE, DMR, FIRAS]
```

```
OBJECT  = 'ALL-SKY '           / part of sky given [e.g., ALL-SKY, WEEKLY-SKY,
COMMENT                        /         DAILY-SKY, GAL-SLICE, FACE ...]
EQUINOX =               2000.0 / equinox of coords in following tables
REFERENC= 'COBE/DIRBE Explanatory Supplement,' /
REFERENC= 'ed. M.G. Hauser, T. Kelsall, D. Leisawitz, and J. Weiland,' /
REFERENC= 'COBE Ref. Pub. No. 97-A (Greenbelt,MD: NASA/GSFC),' /
REFERENC= 'available in electronic form from the NSSDC.' /
COMMENT
COMMENT     COBE specific keywords
DATE-BEG= '11/12/89'           / date of initial data represented (dd/mm/yy)
DATE-END= '21/09/90'           / date of final data represented   (dd/mm/yy)
PIXRESOL=                    9 / Quad tree pixel resolution [6, 9]
COMMENT
COMMENT     DIRBE specific keywords
PRODUCT = 'B1A_AAM '           / Band 1A Annual Average Sky Map
VERSION = 'Pass 3B '           / Version of Data Reduction Software
WAVE1   = '1.25 microns'       / nominal wavelength of Band 1
SOLELONG= 'ALL     '           / all available solar elongations included
APPVEC  = 'COMBINED'           / data having different approach vectors
COMMENT                        / are combined during processing
ZLREMOV =                    F / zodiacal foreground removal indicator
COMMENT                        / if 'T(rue)', zodi foreground has been removed
COMMENT                        / if 'F(alse)', observed sky brightness is given
COMMENT
COMMENT
END

XTENSION= 'BINTABLE'           / Extension type is Binary Table
BITPIX  =                    8 / Binary data
NAXIS   =                    2 / Data are in a table
NAXIS1  =                   27 / Number of 8 bit bytes in each row
NAXIS2  =               393216 / Number of rows
PCOUNT  =                    0 / Number of bytes of data following table
GCOUNT  =                    1 / Group count (always 1 for bintable extensions)
TFIELDS =                    7 / Number of fields (columns) in the table
COMMENT
COMMENT
TIMVERSN= 'OGIP/93-003'        / GSFC Ofice of Guest Investigator Programs (OGIP
COMMENT                        / memo in which the convention is described
COMMENT         The times reported in this file are International
COMMENT         Atomic Time (TAI) seconds elapsed since
COMMENT         00:00:00 UTC, 1 January 1981.  Time information is
COMMENT         recorded in a manner consistent with the convention specified
COMMENT         in OGIP/93-003 with the understanding that time is counted
COMMENT         in atomic seconds and the origin of time (MJDREF) is quoted
COMMENT         in ephemeris MJD.
TIMESYS = '1981.00 '           / time system (same as IRAS)
MJDREFI =                44605 / Integer portion of ephemeris MJD
COMMENT                        / corresponding to 0h UTC 1 Jan 1981
MJDREFF =        0.00059240741 / Fractional portion of ephemeris MJD
COMMENT                        / corresponding to 0h UTC 1 Jan 1981
TIMEUNIT= 's       '           / unit for TSTART, TSTOP, TIMEZERO = seconds
TSTART  =        282185275.611 / observation start time in TIMESYS system
TSTOP   =        306753235.358 / observation stop time in TIMESYS system
```

```
COMMENT
COMMENT
COMMENT   ------------------------------------------------------------------
COMMENT   ******************************************************************
COMMENT          Annual Average Sky Map -- 1.25 microns
COMMENT          Mission-averaged photometric measurements and cumulative
COMMENT          sky coverage data for DIRBE Band 1A (1.25 microns).
COMMENT          The photometry is computed from the weighted average of all
COMMENT          available weekly-averaged maps for the entire mission,
COMMENT          up to the time when the cryogen supply was exhausted.
COMMENT          The foreground signal from Zodiacal dust remains in the map.
COMMENT   ******************************************************************
COMMENT   ------------------------------------------------------------------
COMMENT   ==================================================================
COMMENT   Coordinate Information (Spatial and Temporal):
COMMENT   ==================================================================
COMMENT   ------------------------------------------------------------------
COMMENT       DIRBE Pixel number (resolution 9)
TTYPE1  = 'Pixel_no'           / pipeline fieldname = Pixel_no
TUNIT1  = '        '           /
TFORM1  = '1J      '           /
COMMENT   --------------------------------------------------------------------
COMMENT        Sub-pixel containing the mean DIRBE LOS (line-of-sight)
COMMENT         when pixel is divided into 256
COMMENT         sub-pixels (16x16 grid) according to
COMMENT         standard quad-sphere rules.
TTYPE2  = 'PSubPos '           / pipeline fieldname = Pixel_subpos
TUNIT2  = '        '           /
TFORM2  = '1B      '           /
COMMENT   -------------------------------------------------------------------
COMMENT       Time in International Atomic Time (TAI) seconds
COMMENT       elapsed since 01-JAN-1981:00:00:00.000 UTC.
COMMENT       This is the average time of all observations of a pixel
COMMENT       within the time interval TSTART to TSTOP,
COMMENT       regardless of the weight assigned to a particular observation.
COMMENT       For this product, not a physically meaningful quantity.
TTYPE3  = 'Time    '           / pipeline fieldname = Time
TUNIT3  = '        '           /
TFORM3  = '1D      '           /
COMMENT   ------------------------------------------------------------------
COMMENT   ==================================================================
COMMENT   DIRBE Sky Brightness Information:
COMMENT   ==================================================================
COMMENT   ------------------------------------------------------------------
COMMENT       Cumulative weighted average of the 1.25 micron photometry.
COMMENT        This average is calculated using the weighted number of
COMMENT        observations from each Weekly Averaged Map ( WtNumObs from
COMMENT        the Weekly Averaged Map) as the weight, such that
COMMENT        annual_average =
COMMENT           sum( weekly_average * weekly_weight )/ sum( weekly_weight )
COMMENT
COMMENT        The photometric measurement is given as a
COMMENT        spectral intensity, I(nu) in MJy/sr, and
COMMENT        is quoted at the nominal wavelength
```

```
COMMENT       for a source with nu*I(nu) = constant  -- i.e.,
COMMENT       a color correction is required if the source
COMMENT       spectrum differs from nu*I(nu) = constant.
COMMENT       Data which have been replaced by flagged values
COMMENT       in processing have values .LE. -16375.
COMMENT
TTYPE4  = 'Photomet'          / pipeline fieldname = Photometry
TUNIT4  = 'MJy/sr  '          /
TFORM4  = '1E      '          /
COMMENT  ------------------------------------------------------------------
COMMENT       The standard deviation of the (weighted) average photometry
COMMENT        values.
TTYPE5  = 'StdDev  '          / pipeline fieldname = Standard_deviation
TUNIT5  = 'MJy/sr  '          /
TFORM5  = '1E      '          /
COMMENT  ------------------------------------------------------------------
COMMENT       Sum of the weekly weighted number of observations that went into
COMMENT        forming the annual averages.
TTYPE6  = 'WtNumObs'          / pipeline fieldname = Weighted_num_obs
TUNIT6  = '        '          /
TFORM6  = '1I      '          /
COMMENT  -------------------------------------------------------------------
COMMENT       Sum of the total number of observations available, regardless
COMMENT        of assigned weight.
TTYPE7  = 'SumNRecs'          / pipeline fieldname = Sum_numrecs
TUNIT7  = '        '          /
TFORM7  = '1J      '          /
COMMENT  -------------------------------------------------------------------
END
```

D.1.1.7 Beam Profiles

Table D.1-9: Sample Beam Profile FITS header

```
SIMPLE  =                    T / file does conform to FITS standard
BITPIX  =                  -32 / REAL*4 data
NAXIS   =                    3 / number of data axes
NAXIS1  =                  225 / in-scan axis
NAXIS2  =                  181 / cross-scan axis
NAXIS3  =                    3 / time-period axis
DATE-MAP= '30/06/95'           / Date of original data file creation (dd/mm/yy)
DATE    = '11/02/97'           / FITS file creation date (dd/mm/yy)
ORIGIN  = 'CDAC'               / Cosmology Data Analysis Center
TELESCOP= 'COBE'               / Cosmic Background Explorer satellite
INSTRUME= 'DIRBE'              / COBE instrument [DIRBE, DMR, FIRAS]
OBJECT  = 'BEAM'               / DIRBE beam profile map
REFERENC= 'COBE/DIRBE Explanatory Supplement,' /
REFERENC= 'ed. M.G. Hauser, T. Kelsall, D. Leisawitz, and J. Weiland,' /
REFERENC= 'COBE Ref. Pub. No. 97-A (Greenbelt,MD: NASA/GSFC),' /
REFERENC= 'available in electronic form from the NSSDC.' /
COMMENT
```

```
COMMENT      COBE specific keywords
DATE-BEG= '11/12/89'          / date of initial data represented (dd/mm/yy)
DATE-END= '21/09/90'          / date of final data represented   (dd/mm/yy)
COMMENT
COMMENT      DIRBE specific keywords
PRODUCT = 'BEAM1A'            / DIRBE Band 1A beam profile
VERSION = 'Pass 3B'           / Version of Data Reduction Software
WAVE1   = '1.25 microns'      / nominal wavelength of Band 1
SOLELONG= 'ALL'               / all available solar elongations used
APPVEC  = 'COMBINED'          / data having different approach vectors
COMMENT                       / are combined during processing
COMMENT
COMMENT
COMMENT  -------------------------------------------------------------------
COMMENT  *******************************************************************
COMMENT    Beam Profile -- DIRBE Band 1A.
COMMENT    This is an effective beam profile, which measures the
COMMENT    relative response of the DIRBE to a point source, including
COMMENT    the effects of sky-scanning and data-sampling rates.
COMMENT    Beam profiles are represented as two-dimensional
COMMENT    arrays which give the beam response as a
COMMENT    function of in-scan and cross-scan position.
COMMENT    In-scan position is defined as positive
COMMENT    toward the scan direction, and cross-scan position is
COMMENT    defined as positive toward the spacecraft spin-axis.
COMMENT    The origin (0,0) corresponds to the nominal boresight
COMMENT    position as defined from the attitude solution.
COMMENT
COMMENT    Beam profiles for Band 1A were noted to be
COMMENT    slightly time-dependent.  Therefore, 3 beam profiles are
COMMENT    recorded here, covering the following time intervals (YYDDD):
COMMENT     beam #1: 89345 - 90175 (inclusive)
COMMENT     beam #2: 90176 - 90231 (inclusive)
COMMENT     beam #3: 90232 - 90264 (inclusive)
COMMENT
COMMENT    Beam #1 is normalized to a value of 1.0 at the
COMMENT    location of peak response.  Beams #2 and #3
COMMENT    are normalized such that the beam profile solid angle
COMMENT    is constant during the cold mission, using the solid angle
COMMENT    found for Beam #1.  The peak response of beams #2 and #3
COMMENT    differs from unity by less than 1%.
COMMENT
COMMENT    The beam solid angle for Band 1A used in the Pass3B data
COMMENT    processing is  1.198 e-04 sr.
COMMENT  *******************************************************************
COMMENT  -------------------------------------------------------------------
CRVAL1  =             0.000000 / Value at origin (arcmin)
CRPIX1  =                  113 / position of origin
CTYPE1  = 'INSCAN'             / in-scan coordinate; range +- 42 arcmin
CDELT1  =             0.375000 / in-scan sampling increment, arcmin per pixel
COMMENT  -------------------------------------------------------------------
CRVAL2  =             0.000000 / Value at origin (arcmin)
CRPIX2  =                   91 / position of origin
CTYPE2  = 'XSCAN'              / x-scan coordinate; range +- 36 arcmin
```

```
CDELT2  =             0.400000 / x-scan sampling increment, arcmin per pixel
COMMENT  -------------------------------------------------------------------
CRVAL3  =                    1 /
CRPIX3  =                    1 /
CTYPE3  = 'BEAM-NO'            / beam number; range 1-3
CDELT3  =                    1 /
COMMENT  -------------------------------------------------------------------
END
```

D.1.2 FORTRAN Access to the *DIRBE* Data Products

The *FITSIO* subroutines mentioned in §D.1 may be called from a FORTRAN program in order to read FITS–encoded data. The following examples illustrate how FORTRAN programs can be used to read the Solar Elongation = 90° Sky Maps and the DIRBE_SKYMAP_INFO.FITS file.

D.1.2.1 Access to the $\varepsilon = 90°$ Sky Maps

```
         program dirbe_e90_read

c       ----------------------------------------------------------------
c        A simple program to read the FITS binary table data from the
c        DIRBE pixelized Solar Elongation = 90 degree Sky Maps. This
c        program uses the FITSIO package developed by HEASARC at NASA GSFC.
c        This program reads in the PHOTOMET field which contains the
c        actual data. Also read in are the PIXEL_NO, TIME and STDDEV field.
c        The STDDEV is then unpacked into the quantity SIGMA for each pixel
c        for the given band.
c       ----------------------------------------------------------------

         implicit          none

         integer maxdim
         parameter (maxdim = 20)

         character*30       errtxt,extnam
         character*30       ttype(maxdim), tform(maxdim), tunit(maxdim)
         character*80       filename
         character*80       comment
         character*12       c_res

         logical   simple, extend, anyflg

         integer   iunit, status, bitpix, naxis, naxes(maxdim)
         integer   pcount, gcount
         integer   group, nelem, nrows
         integer   i, j, itemp, n, k
         integer   tfield, rwstat, bksize, vardat
         integer   colnum, frow, felem
         integer   hdutyp, inull
c
         integer   res, pixel(616474)
         integer   bandno
         integer*2   stddev(616474)
```

```
        real     photomet(616474), enull, sigma(616474)
        real*8     time(616474)

        status = 0
        iunit = 15

c      -----------------------------------------------------------------
c       open the existing   FITS file with readonly access
c      -----------------------------------------------------------------
        rwstat = 0
        print *, 'Enter file name '
 read(*,2000) filename
2000  format(a)
        print *, 'Enter Band number '
 read(*,2001) bandno
2001  format(i)
        call ftopen(iunit, filename, rwstat, bksize, status)
        if (status .ne. 0) goto 1000

c      -----------------------------------------------------------------
c       read in the required primary array keywords
c      -----------------------------------------------------------------
        call ftghpr(iunit, maxdim, simple, bitpix, naxis, naxes,
     %                          pcount, gcount, extend, status)
        if (status .ne. 0) goto 1000

c      -----------------------------------------------------------------
c       Get in the COBE specific field, RES which defines the resolution
c       of the data.  This is used to calculate the pixel numbers which
c       correspond to a specific face of the skycube.
c      -----------------------------------------------------------------
        call ftgkey(iunit, 'PIXRESOL', c_res, comment, status)
        read(c_res, '(i1)') res
        print*, 'This file is at resolution: ',res

c      -----------------------------------------------------------------
c       now move onto the binary table extension
c      -----------------------------------------------------------------
        call ftmahd(iunit, 2, hdutyp, status)
        if (status .ne. 0) goto 1000

c      -----------------------------------------------------------------
c       get the binary table parameters
c      -----------------------------------------------------------------
        call ftghbn(iunit, maxdim, nrows, tfield, ttype, tform,
     %                          tunit, extnam, vardat, status)
        if (status .ne. 0) goto 1000

        print *, 'nrows:  ',nrows

c      -----------------------------------------------------------------
c       test that this is a DIRBE dataset, by looking at a few field names
c      -----------------------------------------------------------------
        if (ttype(1) .ne. 'Pixel_no' .or.
```

```
     %             ttype(3) .ne. 'Photomet' .or.
     %             ttype(5) .ne. 'StdDev') then
                print *, 'This is not a DIRBE PDS/IP file'
                print *, 'ttype(1) = ', ttype(1)
                print *, 'ttype(3) = ', ttype(3)
                print *, 'ttype(5) = ', ttype(5)
                goto 1000
        endif

c       ----------------------------------------------------------------
c       read in the pixel, photomet and photqual fields
c       ----------------------------------------------------------------
        write(6,*) 'reading in the data now'
        do 100 frow = 1, nrows
            felem = 1
            nelem = 1
            inull = 0

            colnum = 1
            call ftgcvj(iunit, colnum, frow, felem, nelem, enull,
     %                      pixel(frow), anyflg, status)
            if (status .ne. 0) write(6,*) '1frow:',frow,' status:',
     %                      status
            if (status .ne. 0) goto 1000

            colnum = 2
            call ftgcvd(iunit, colnum, frow, felem, nelem, enull,
     %                      time(frow), anyflg, status)
            if (status .ne. 0) write(6,*) '1frow:',frow,' status:',
     %                      status
            if (status .ne. 0) goto 1000

c         ----------------------------------------------------------------
c          note that for the photomet field and the phtoqual field we take
c          10 as the number of elements to read in.
c         ----------------------------------------------------------------
            colnum = 3
            call ftgcve(iunit, colnum, frow, felem, nelem, enull,
     %                      photomet(frow), anyflg, status)
            if (status .ne. 0) write(6,*) '2frow:',frow,' status:',
     %                         status
            if (status .ne. 0) goto 1000

            colnum = 5
            call ftgcvi(iunit, colnum, frow, felem, nelem, enull,
     %                      stddev(frow), anyflg, status)
            if (status .ne. 0) write(6,*) '3frow:',frow,' status:',
     %                      status
            if (status .ne. 0) goto 1000

c       ----------------------------------------------------------------
c       extract the proper bytes from the PhotQual field
c       ----------------------------------------------------------------
```

```
          N = 3
          I=bandno
          IF (I .GT. 8) N = 1
          IF (I .EQ. 5) N = 4
          IF (I .EQ. 6) N = 4
          IF (stddev(frow) .EQ. 0) THEN
             SIGMA(frow) = 10.0**-N
          ELSEIF (stddev(frow) .EQ. 255) THEN
             SIGMA(frow) = 10.0**(-N+4)
          ELSE
             SIGMA(frow) = 10.0**((stddev(frow) - 0.5)/63.5 - N)
          ENDIF

c       -----------------------------------------------------------------
c        NOTE, in the Initial Products AND some of the PDS the SIGMA's
c        for Bands 1-8 are reported as relative SIGMA's while Bands 9
c        and 10 are absolute SIGMA's.
c       -----------------------------------------------------------------

          IF (I .LE. 8) SIGMA(frow) =
     %            SIGMA(frow)*ABS(photomet(frow))
 100     continue
         write(6,*) 'done reading in the data'

c       -----------------------------------------------------------------
c        now close the table and quit
c       -----------------------------------------------------------------
         call ftclos(iunit, status)

         print *, 'next line is pixel,time,photomet,stddev(0-255),sigma'
         do j=1,10
          print *,pixel(j),time(j),photomet(j),stddev(j),sigma(j)
         end do

 1000     if (status .le. 0) then
             print *, '*** Program completed successfully ***'
         else
c           -----------------------------------------------------------------
c            get the error description
c           -----------------------------------------------------------------
             call ftgerr(status, errtxt)
             print *, '*** Error, program did not run successfully ***'
             print *, 'status =',status,': ',errtxt
         endif

         end
```

D.1.2.2 Access to the Skymap Information Maps

```
        program skyinfo

C       A simple program to read in the primary data array from
```

```
C       the DIRBE_SKYMAP_INFO FITS file. The primary header is
C       also printed out in its entirety. The output array
C       PIXNUM is a 256,256,6 array where the third dimension
C       is the face number (i.e. 6 faces 0-5) and the first two
C       dimensions are the x and y positions. The value at any
C       given point is the pixel number at that point.

C       The orientation of the output is:

COMMENT             row  -------------------
COMMENT              n   |                 |     n = NAXIS1 = NAXIS2
COMMENT              ^   |                 |     n = 256
COMMENT              |   |                 |
COMMENT              2   |                 |
COMMENT              1   |                 |
COMMENT                  -------------------
COMMENT                   1 2    -->      n
COMMENT                        column


        integer iunit,status,bitpix,naxis,naxes(99),pcount,gcount
        integer group,fpixel,nelem,i,j,rwstat,bksize
        integer hdutyp,inull,nkeys,nmore
        integer*4 pixnum(256,256,6)
        logical simple,extend,anyflg
        character*30 errtxt
        character*80 fname,comm,record

        status=0
        iunit=15
C       open the existing FITS file with readonly access
        rwstat=0
print *, 'Enter file name '
read(*,2000) fname
2000 format(a)
        call ftopen(iunit,fname,rwstat,bksize,status)

C       read the required primary array keywords
        call ftghpr(iunit,99,simple,bitpix,naxis,naxes,pcount,gcount,
     &       extend,status)
        if (status .ne. 0)go to 99

C find out the number of keywords in the header
call ftghsp(iunit,nkeys,nmore,status)

C print out each keyword
do 10 i=1,nkeys
call ftgrec(iunit,i,record,status)
print *,record
10 continue

C       first, test to make sure this is a 3D array
        if (naxis .ne. 3)then
            print *,'This program only works on a 3D FITS array'
```

```
            go to 100
        end if

C       read the raster
        inull=0
        group=0
        fpixel=1
        call ftg3dj(iunit,group,inull,naxes(1),naxes(2),naxes(1),
     &    naxes(2),naxes(3),pixnum,anyflag,status)

C       now close the table and quit
        call ftclos(iunit,status)

99      if (status .le. 0)then
                print *,'*** Program completed successfully ***'
        else
C          get the error text description
           call ftgerr(status,errtxt)
           print *,'*** ERROR - program did not run successfully ***'
           print *,'status =',status,': ',errtxt
        end if

100     continue
        end
```

D.1.2.3 Pixel Number to Coordinate Conversion

The following FORTRAN routines convert CSC pixel numbers (see §5.3) to longitude and latitude in the specified coordinate system (ecliptic, Galactic, or equatorial). The UIDL software described in §D.1.3 also has this capability. These routines apply only to Quadrilateralized Spherical Cubes of "resolution 9" or less. Standard *DIRBE* pixels are at resolution 9. The main program, `pix2ll`, is intended to be used as the basis for more comprehensive programs. Later in this section are listings of the `SUPER_CENPIX` and `SUPER_PIXNO` routines and associated subroutines, which work with "resolution 15" pixels.

```
       program pix2ll
!
!  NAME:
!    pixel_2_uvec_2_lonlat
!
!  PURPOSE:
!        Routine returns longitude and latitude pointing to center of
!        pixel given pixel number and resolution of the cube. The coordinate
!        system is an input. Note, all coordintes are at epoch=J2000.
!        Additionally the spherical quadrilateralized cube face ,x, y
!        positions can be returned.
!
!  CALLING SEQUENCE:
!    pix2ll (pixel, resolution, coord) > longitude,latitude
!
!  INPUT:
!    pixel -  Pixel number
!    resolution - Quad-cube resolution
```

```
!    coord - output coordinate system
!
!  OUTPUT:
!    vector - Longitude and latitude of center of pixel
!
!  SUBROUTINES CALLED:
!    PIXEL_VECTOR, FORWARD_CUBE, XYAXIS
!    UV2ll, CONV_E2G, CONV_E2Q
!
!  REVISION HISTORY
!
      Implicit NONE
C
C  Arguments:
C
      character*1    COORD         ! Coordinate System
      integer*2      RESOLUTION    ! Quad-cube resolution
      integer*4      ISTAT         ! Status
      integer*4      UV2ll         ! Routine convert unit vector to lon/lat
      integer*4      PIXEL         ! Pixel number
      integer*4      X,Y,FACE      ! Face x,y coordinates for quad-cube,
                                   ! where 0,0 is in bottom right hand
                                   ! corner of face. There are 6 faces.
      real*4         VECTOR(3)     ! Temp. unit vector to center of pixel
      real*4         OVECTOR(3)    ! Unit vector to center of pixel
      real*4         PIXEL_VECTOR  ! Routine computes unit vectors
      real*4         CONV_E2Q, CONV_E2G !Convert from ecliptic to galactic
                                        !and ecliptic to equatorial
      real*4         longitude,latitude  !output longitude and latitude

C
      print *,'Enter pixel:'
      read(*,25) pixel
 25   format(i8)
      print *,'Enter resolution:'
      read(*,35) resolution
 35   format(i2)
      call PIXEL_VECTOR(pixel,resolution,vector,x,y,face)
      print *,'Enter output format: '
      print *,'(L=longitude/latitude, P=quad cube x,y,face positions)'
      read(*,45) coord
      if (coord .eq. 'P' .or. coord .eq. 'p') then
        print *,'Face= ',face
        print *,'X,Y= ',x,y
      else
        print *,'Enter coordinate system ',
     &          '(E=ecliptic,G=galactic,Q=Equatorial):'
        read(*,45) coord
 45     format(A)
        if (coord .eq. 'G' .or. coord .eq. 'g')
     &            call CONV_E2G(vector,ovector)
        if (coord .eq. 'Q' .or. coord .eq. 'q')
     &            call CONV_E2Q(vector,ovector)
        if (coord .eq. 'E' .or. coord .eq. 'e') then
```

```
          ovector(1)=vector(1)
          ovector(2)=vector(2)
          ovector(3)=vector(3)
        endif

        istat=UV2LL(ovector,longitude,latitude)
        print *,coord,' lat lon=',latitude,longitude
      endif
      end

*******************************************************************************
      Subroutine conv_E2G(ivector,ovector)
C
C    Routine to convert ecliptic (celestial) coordinates at the given
C  epoch to galactic coordinates.
C
C                        --------------
C
C  Galactic Coordinate System Definition (from Zombeck, "Handbook of
C  Space Astronomy and Astrophysics", page 71):
C
C        North Pole:  12:49       hours right ascension (1950.0)
C                    +27.4        degrees declination   (1950.0)
C
C    Reference Point:  17:42:26.603     hours right ascension (1950.0)
C                     -28 55' 00.45     degrees declination   (1950.0)
C
C                        --------------
C
C
      Implicit NONE
C
C  Arguments:
C
      Real*4     IVECTOR(3)      ! Input coordinate vector
      Real*4     OVECTOR(3)      ! Output coordinate vector
C
C  Program variables:
C
      Real*8     T(3,3)          ! Galactic coordinate transformation matrix
      Integer*2  I,J             ! Loop variables
C
      Data T / -0.054882486d0, -0.993821033d0, -0.096476249d0, ! 1st column
     +          0.494116468d0, -0.110993846d0,  0.862281440d0, ! 2nd column
     +         -0.867661702d0, -0.000346354d0,  0.497154957d0/ ! 3rd column
C
C     Multiply vector by transpose of transformation matrix:
C
      Do 200 I = 1,3
          ovector(i) = 0.0
          Do 100 J = 1,3
  100        ovector(i) = ovector(i) + ivector(j)*T(j,i)
  200   end do
C
```

```
      return
      end

*****************************************************************************
      Subroutine conv_E2Q(ivector,ovector)
C
C    Routine to convert from ecliptic coordinates to equatorial (celestial)
C  coordinates at the given epoch.
C
      Implicit NONE
C
C  Arguments:
C
      Real*4      IVECTOR(3)     ! Input coordinate vector
      Real*4      OVECTOR(3)     ! Output coordinate vector
C
C  Program variables:
C
      Real*8      T              ! Julian centuries since 1900.0
      Real*4      EPOCH          ! Equatorial coordinate epoch
      Real*8      EPSILON        ! Obliquity of the ecliptic
C
C  Set-up:
C
      epoch=2000.
      T = (epoch - 1900.d0) / 100.d0
      epsilon = 23.452294d0 - 0.0130125d0*T - 1.63889d-6*T**2
     +           + 5.02778d-7*T**3
C
C  Conversion:
C
      ovector(1) = ivector(1)
      ovector(2) = dcosd(epsilon)*ivector(2) - dsind(epsilon)*ivector(3)
      ovector(3) = dcosd(epsilon)*ivector(3) + dsind(epsilon)*ivector(2)
C
      return
      end

C*****************************************************************************
c*     UV2LL
c*
c*     Function: Convert from unit three-vector to decimal latitude and
c*               longitude, in degrees.  Longitude is between 0 and 360.
c*
c*     PROLOGUE:
c*
c*     INPUT DATA:  three-vector
c*
c*     OUTPUT DATA: latitude and longitude in degrees
c*
c*     INVOCATION:  status=UV2LL(vector,longitude,latitude)
c*
c*     INPUT PARAMETERS:
c*
```

```
c*     Name                Type          Description
c*     ----                ----          -----------
c*
c*    vector              real*4(3)     coordinate vector
c*
c*     OUTPUT PARAMETERS:
c*
c*     Name                Type          Description
c*     ----                ----          -----------
c*
c*    longitude           real*4        in degrees
c*    latitude            real*4        in degrees
c*
c*     COMMON VARIABLES USED: none
c*
c*     SUBROUTINES CALLED:    none
c*
c*     FUNCTIONS CALLED:      none
c*
c*     PROCESSING METHOD:
c*
c*     BEGIN
c*
c*       Normalize input vector
c*       If pole:
c*           longitude = 0
c*         else
c*           calculate longitude
c*         endif
c*       Make sure longitude is positive
c*       Calculate latitude
c*       Return
c*
c*     END
c********************************************************************************
c*
      Integer*4 Function UV2LL(vector,longitude,latitude)

      Implicit NONE
c
c  Arguments:
c
      Real*4         VECTOR(3)    ! coordinate vector
      Real*4         LONGITUDE    ! in degrees
      Real*4         LATITUDE     ! in degrees
c
c  Variables:
c
      Real*4         V(3)         ! Normalized VECTOR
      Real*4         NORM_INV     ! 1 / VECTOR norm
c
c     Normalize input vector:
c
      norm_inv = sqrt(vector(1)**2 + vector(2)**2 + vector(3)**2)
```

```
      if (norm_inv .eq. 0) then
          print *,'Unit vector normalization is 0'
          uv2ll = 0
          return
        else
          norm_inv = 1.0 / norm_inv
        endif

      v(1) = vector(1) * norm_inv
      v(2) = vector(2) * norm_inv
      v(3) = vector(3) * norm_inv
c
c     Conversion:
c
      if (v(2) .eq. 0.0 .and. v(1) .eq. 0.0) then
          longitude = 0.0
        else
          longitude = atan2d(v(2),v(1))
        endif
      if (longitude .lt. 0.0) longitude = longitude + 360.0

      latitude = atan2d(v(3),sqrt(v(1)**2+v(2)**2))
c
c     Done:
c
      uv2ll = 1
      return
      end

********************************************************************************
SUBROUTINE FORWARD_CUBE(X,Y,XI,ETA)
REAL*4 X,Y,XI,ETA
C
C INPUT: X,Y IN RANGE -1 TO +1 ARE DATABASE CO-ORDINATES
C
C OUTPUT: XI, ETA IN RANGE -1 TO +1 ARE TANGENT PLANE CO-ORDINATES
C
C BASED ON POLYNOMIAL FIT FOUND USING FCFIT.FOR
C
PARAMETER (NP=28)
REAL*4 P(NP)
DATA P/
1  -0.27292696, -0.07629969, -0.02819452, -0.22797056,
2  -0.01471565,  0.27058160,  0.54852384,  0.48051509,
3  -0.56800938, -0.60441560, -0.62930065, -1.74114454,
4   0.30803317,  1.50880086,  0.93412077,  0.25795794,
5   1.71547508,  0.98938102, -0.93678576, -1.41601920,
6  -0.63915306,  0.02584375, -0.53022337, -0.83180469,
7   0.08693841,  0.33887446,  0.52032238,  0.14381585/
XX=X*X
YY=Y*Y
XI=X*(1.+(1.-XX)*(
1 P(1)+XX*(P(2)+XX*(P(4)+XX*(P(7)+XX*(P(11)+XX*(P(16)+XX*P(22)))))) +
2 YY*( P(3)+XX*(P(5)+XX*(P(8)+XX*(P(12)+XX*(P(17)+XX*P(23))))) +
```

```
3 YY*( P(6)+XX*(P(9)+XX*(P(13)+XX*(P(18)+XX*P(24)))) +
4 YY*( P(10)+XX*(P(14)+XX*(P(19)+XX*P(25))) +
5 YY*( P(15)+XX*(P(20)+XX*P(26)) +
6 YY*( P(21)+XX*P(27) + YY*P(28))))) )))
ETA=Y*(1.+(1.-YY)*(
1 P(1)+YY*(P(2)+YY*(P(4)+YY*(P(7)+YY*(P(11)+YY*(P(16)+YY*P(22)))))) +
2 XX*( P(3)+YY*(P(5)+YY*(P(8)+YY*(P(12)+YY*(P(17)+YY*P(23))))) +
3 XX*( P(6)+YY*(P(9)+YY*(P(13)+YY*(P(18)+YY*P(24)))) +
4 XX*( P(10)+YY*(P(14)+YY*(P(19)+YY*P(25))) +
5 XX*( P(15)+YY*(P(20)+YY*P(26)) +
6 XX*( P(21)+YY*P(27) + XX*P(28))))) )))
RETURN
END

******************************************************************************
SUBROUTINE XYAXIS(NFACE,XI,ETA,C)
C
C CONVERTS FACE NUMBER NFACE (0-5) AND XI, ETA (-1. - +1.)
C INTO A UNIT VECTOR C
C
REAL*4 C(3),XI,ETA,XI1,ETA1,NORM
C
C To preserve symmetry, the normalization sum must
C always have the same ordering (i.e. largest to smallest).
C
        XI1  = MAX(ABS(XI),ABS(ETA))
        ETA1 = MIN(ABS(XI),ABS(ETA))
        NORM = 1. / SQRT(1. + XI1**2 + ETA1**2)
C
GO TO (200,210,220,230,240,250), NFACE+1
200   C(3)=NORM !Transform face to sphere
  C(1)=-ETA*NORM
  C(2)=XI*NORM
  GO TO 300
210   C(1)=NORM
  C(3)=ETA*NORM
  C(2)=XI*NORM
  GO TO 300
220   C(2)=NORM
  C(3)=ETA*NORM
  C(1)=-XI*NORM
  GO TO 300
230   C(1)=-NORM
  C(3)=ETA*NORM
  C(2)=-XI*NORM
  GO TO 300
240   C(2)=-NORM
  C(3)=ETA*NORM
  C(1)=XI*NORM
  GO TO 300
250   C(3)=-NORM
  C(1)=ETA*NORM
  C(2)=XI*NORM
  GO TO 300
```

```
C
 300 CONTINUE
C
RETURN
END

*******************************************************************************

      Subroutine PIXEL_VECTOR(pixel,resolution,vector,jx,jy,face)
C
C    Routine to return unit vector pointing to center of pixel given pixel
C  number and resolution of the cube.
C
      Implicit NONE
C
C  Arguments:
C
      Integer*4      PIXEL         ! Pixel number
      Integer*2      RESOLUTION    ! Quad-cube resolution
      Real*4         VECTOR(3)     ! Unit vector to center of pixel
C
C  Variables:
C
      Integer*4      FACE             ! Face number
      Integer        JX,JY,IP,ID      ! Loop variables
      Real           X,Y              ! Face coordinates
      Real*4         SCALE
      Integer*4      PIXELS_PER_FACE  ! Number of pixels on a single face
      Integer*4      FPIX             ! Pixel number within the face
      Real           XI,ETA           ! 'Database' coordinates
      Integer*4      ONE,TWO          ! Constants used to avoid integer
                                      !   overflow for large pixel numbers
      Integer*4      BIT_MASK         ! Bit mask to select the low order bit
C
      Parameter (ONE = 1)
      Parameter (TWO = 2)
      Parameter (BIT_MASK = 1)
C
      scale = 2**(resolution-1) / 2.0
      pixels_per_face = two**(two*(resolution-one))
C
      face = pixel/pixels_per_face          ! Note: Integer division truncates
      fpix = pixel - face*pixels_per_face
C
C  Break pixel number down into x and y bits:
C
      jx = 0
      jy = 0
      ip = 1
      do while (fpix .ne. 0)
          id = iand(bit_mask,fpix)  !  = mod(fpix,2)
          fpix = ishft(fpix,-1)     !  = fpix / 2
          jx = id * ip + jx
          id = iand(bit_mask,fpix)
```

```
          fpix = ishft(fpix,-1)
          jy = id * ip + jy
          ip = ip * 2
        end do
C
      x = (jx - scale + 0.5) / scale
      y = (jy - scale + 0.5) / scale
      call FORWARD_CUBE(x,y,xi,eta)
      call XYAXIS(face,xi,eta,vector)
C
      return
      end
```

****

The following routines perform “resolution 15” pixel calculations. SUPER_CENPIX accepts a resolution 15 pixel number as input and computes the corresponding line of sight unit vector; SUPER_PIXNO performs the opposite transformation. The FORWARD_CUBE subroutine, which is called by SUPER_CENPIX, is listed above.

****

```
SUBROUTINE AXISXY(C,NFACE,X,Y)
C
C CONVERTS UNIT VECTOR C INTO NFACE NUMBER (0-5) AND X,Y
C IN RANGE 0-1
C
REAL*4 C(3)
AC3=ABS(C(3))
AC2=ABS(C(2))
AC1=ABS(C(1))
IF(AC3.GT.AC2) THEN
   IF(AC3.GT.AC1) THEN
      IF(C(3).GT.0.) GO TO 100
GO TO 150
   ELSE
      IF(C(1).GT.0.) GO TO 110
GO TO 130
   ENDIF
ELSE
   IF(AC2.GT.AC1) THEN
      IF(C(2).GT.0.) GO TO 120
GO TO 140
   ELSE
      IF(C(1).GT.0.) GO TO 110
GO TO 130
   ENDIF
ENDIF
100 NFACE=0
ETA=-C(1)/C(3)
XI=C(2)/C(3)
GO TO 200
110 NFACE=1
XI=C(2)/C(1)
```

```
ETA=C(3)/C(1)
GO TO 200
120 NFACE=2
ETA=C(3)/C(2)
XI=-C(1)/C(2)
GO TO 200
130 NFACE=3
ETA=-C(3)/C(1)
XI=C(2)/C(1)
GO TO 200
140 NFACE=4
ETA=-C(3)/C(2)
XI=-C(1)/C(2)
GO TO 200
150 NFACE=5
ETA=-C(1)/C(3)
XI=-C(2)/C(3)
GO TO 200
C
200 CALL INCUBE(XI,ETA,X,Y)
X=(X+1.)/2.
Y=(Y+1.)/2.
RETURN
END

********************************************************************************

SUBROUTINE INCUBE(ALPHA,BETA,X,Y)
C
C SEE CSC "EXTENDED STUDY ... NOTE THAT THE TEXT HAS TYPOS.  I HAVE
C TRIED TO COPY THE FORTRAN LISTINGS
c*
c*     PROLOGUE:
c*
ch     Date    Version   SPR#   Programmer    Comments
ch     ----    -------   ----   ----------    --------
ch
ch   08/20/90    6.7     7003   A.C.Raugh     Minor modifications to improve
ch                                            efficiency
ch
C
REAL*4 ALPHA,BETA
        Real*4 GSTAR_1,M_G,C_COMB
PARAMETER GSTAR=1.37484847732,G=-0.13161671474,
1   M=0.004869491981,W1=-0.159596235474,C00=0.141189631152,
2   C10=0.0809701286525,C01=-0.281528535557,C11=0.15384112876,
3   C20=-0.178251207466,C02=0.106959469314,D0=0.0759196200467,
4   D1=-0.0217762490699
PARAMETER R0=0.577350269
AA=ALPHA**2
BB=BETA**2
A4=AA**2
B4=BB**2
ONMAA=1.-AA
```

```
ONMBB=1.-BB

        gstar_1 = 1. - gstar
        m_g     = m - g
        c_comb  = c00 + c11*aa*bb

X = ALPHA *
     +       (GSTAR +
     +        AA * gstar_1 +
     +        ONMAA * (BB * (G + (m_g)*AA +
     +                      ONMBB * (c_comb + C10*AA + C01*BB +
     +                                C20*A4 + C02*B4)) +
     +                AA * (W1 - ONMAA*(D0 + D1*AA))))

Y = BETA *
     +       (GSTAR +
     +        BB * gstar_1 +
     +        ONMBB * (AA * (G + (m_g)*BB +
     +                       ONMAA * (c_comb + C10*BB + C01*AA +
     +                                C20*B4+C02*A4)) +
     +                 BB * (W1 - ONMBB*(D0 + D1*BB))))
RETURN
END

********************************************************************************

SUBROUTINE SPRCNPX_SET
C
INTEGER*2 JX,JY
COMMON /SPRCNPX/ JX(0:1023),JY(0:1023)
DATA JX(1023)/0/
C
SAVE /SPRCNPX/
DO KPIX=0,1023
  JPIX=KPIX
  IX=0
  IY=0
  IP=1
  DO WHILE (JPIX.NE.0) !Break up the pixel number
    ID=MOD(JPIX,2) !By even and odd bits to get
    JPIX=JPIX/2 !IX and IY
    IX=ID*IP+IX
    ID=MOD(JPIX,2)
    JPIX=JPIX/2
    IY=ID*IP+IY
    IP=2*IP
  ENDDO
  JX(KPIX)=IX
  JY(KPIX)=IY
ENDDO
RETURN
END

********************************************************************************
```

```
SUBROUTINE SUPER_CENPIX(NSUPER,C)
INTEGER*4 NSUPER !Input pixel number
REAL*4 C(3) !Output unit vector
PARAMETER IT28=2**28
C
INTEGER*2 IX,IY
COMMON /SPRCNPX/ IX(0:1023),IY(0:1023)
IF(IX(1023).NE.31) CALL SPRCNPX_SET
C
NFACE=NSUPER/IT28
N=MOD(NSUPER,IT28)
I=MOD(N,1024)
N=N/1024
J=MOD(N,1024)
K=N/1024
JX=1024*IX(K)+32*IX(J)+IX(I)
JY=1024*IY(K)+32*IY(J)+IY(I)
X=(JX-8191.5)/8192. !Database coordinates.  Range
Y=(JY-8191.5)/8192. ! -1 -> 1 covers the square face
CALL FORWARD_CUBE(X,Y,XI,ETA) !Distort to tangent plane
C
C TWO ITERATIONS TO IMPROVE THE DISTORTION
C
CALL INCUBE(XI,ETA,XP,YP)
XI=XI-(XP-X)
ETA=ETA-(YP-Y)
CALL INCUBE(XI,ETA,XP,YP)
XI=XI-(XP-X)
ETA=ETA-(YP-Y)
CALL XYAXIS(NFACE,XI,ETA,C)
RETURN
END

********************************************************************************

SUBROUTINE SUPER_PIXNO(C,NSUPER)
REAL*4 C(3) !Unit vector input
INTEGER*4 NSUPER !Output pixel number 1,...,6*2**28
PARAMETER IT14=16384,IT28=2**28
C
C PIXELIZES SPHERE TO 20" ACCURACY, EQUAL-AREA PIXELS USING
C QUADRILATERIZED SPHERICAL CUBE
C
INTEGER*4 NPIX,IX,IY,K,IP
SAVE /SPRBIT/
COMMON /SPRBIT/ IX(128),IY(128)
DATA IX(128) /0/
IF(IX(128).EQ.0) THEN !Set up the lookup tables
   DO I=1,128 !for converting x,y into
      J=I-1 !pixel numbers
      K=0
      IP=1
10       IF(J.EQ.0) THEN
```

```
IX(I)=K
IY(I)=2*K
      ELSE
ID=MOD(J,2)
J=J/2
K=IP*ID+K
IP=IP*4
GO TO 10
      ENDIF
   ENDDO
ENDIF
CALL AXISXY(C,NFACE,X,Y)
I=IT14*X
J=IT14*Y
I=MIN(IT14-1,I) !Roundoff protection for cases very
J=MIN(IT14-1,J) !near an edge of the cube
IL=MOD(I,128)
IH=I/128
JL=MOD(J,128)
JH=J/128
NSUPER=NFACE*IT28+IX(IL+1)+IY(JL+1)+IT14*(IX(IH+1)+IY(JH+1))
RETURN
END

*********************************************************************************

SUBROUTINE XYAXIS(NFACE,XI,ETA,C)
C
C CONVERTS FACE NUMBER NFACE (0-5) AND XI, ETA (-1. - +1.)
C INTO A UNIT VECTOR C
c*
c*     PROLOGUE:
c*
ch     Date    Version   SPR#   Programmer    Comments
ch     ----    -------   ----   ----------    --------
ch
ch  08/20/90     6.7     7003   A.C.Raugh     Minor modifications to improve
ch                                            efficiency
ch  03/06/92     9.4     9571   A.C.Raugh     Replaced algorithm with one
ch                                            provided by Phil Keegstra (DMR)
ch                                            to provide/use cube face symmetry
ch
C
REAL*4 C(3),XI,ETA,XI1,ETA1,NORM
C
C To preserve symmetry, the normalization sum must
C always have the same ordering (i.e. largest to smallest).
C
        XI1  = MAX(ABS(XI),ABS(ETA))
        ETA1 = MIN(ABS(XI),ABS(ETA))
        NORM = 1. / SQRT(1. + XI1**2 + ETA1**2)
C
GO TO (200,210,220,230,240,250), NFACE+1
200   C(3)=NORM !Transform face to sphere
```

```
  C(1)=-ETA*NORM
  C(2)=XI*NORM
  GO TO 300
210   C(1)=NORM
  C(3)=ETA*NORM
  C(2)=XI*NORM
  GO TO 300
220   C(2)=NORM
  C(3)=ETA*NORM
  C(1)=-XI*NORM
  GO TO 300
230   C(1)=-NORM
  C(3)=ETA*NORM
  C(2)=-XI*NORM
  GO TO 300
240   C(2)=-NORM
  C(3)=ETA*NORM
  C(1)=XI*NORM
  GO TO 300
250   C(3)=-NORM
  C(1)=ETA*NORM
  C(2)=XI*NORM
  GO TO 300
C
 300 CONTINUE
C
RETURN
END
```

D.1.3 IDL Access to the *DIRBE* Data Products

The following example illustrates how the *IDL Astronomy User's Library* routines `headfits, readfits, and tbget` can be used to read the *DIRBE* Galactic Plane Maps FITS file. The *Library* can be obtained over the Web from the address given in §D.1.

```
IDL> filename = 'dirbe_galactic_plane_maps.fits'    ; specify file name

IDL> mainhead = headfits(filename)          ; read primary FITS header
                                            ; and store it in the string
                                            ; array "mainhead"

IDL> table = readfits(filename, exthead, /exten)
                                            ; read FITS binary table,
                                            ; store data in array "table"
                                            ; and extension header in string
                                            ; array "exthead"

IDL> phot = tbget(exthead, table, 'Photomet')
                                            ; store photometric data in
                                            ; array "phot." Dimensions of
                                            ; array are 10 (DIRBE bands) x
                                            ; number of pixels in map
```

The following example illustrates how the *COBE* analysis software (UIDL) can be used to read photometric data from the *DIRBE* 1.25 μm $\varepsilon = 90°$ Sky Map, represent the data as a 1024×512 pixel Mollweide projection in Galactic coordinates, and save the image in a color Postscript file:

```
UIDL> datain, 'dirbe_band1_elongation90_skymap.fits', $    ; read in photometry and
UIDL>  dsfield = 'photomet', data = data                   ; store in array "data"

UIDL> reproj, data, proj_map, proj = 'm', coord = 'g', psize = 'l' ; reproject data
                                                                   ; into new array
                                                                   ; "proj_map"

UIDL> psimage, proj_map, color = 3, output = 'dirbe_band1.ps'  ; create a Postscript
                                                               ; file called
                                                               ; "dirbe_band1.ps"
                                                               ; using default IDL
                                                               ; color table 3
```

D.2 Sample Data Plots and Dumps

The following tables list the data for pixel 42 (selected arbitrarily) from each of several representative FITS files [1] and may be used to check software designed to read the *DIRBE* data products. Tables D.2-1, D.2-2, D.2-3, and D.2-4 give excerpts from the Galactic Plane Maps file, Weekly Sky Map number 22, and the Annual Average and $\varepsilon = 90°$ Sky Maps, respectively.

Table D.2-1: Data for pixel 42 in the Galactic Plane Maps

File	`DIRBE_GALACTIC_PLANE_MAPS.FITS`									
Time (T81)	294533016.795 s									
Coordinates	**Ecliptic**					**Galactic**				
longitude	312°.38					59°.38				
latitude	36°.65					−9°.93				
Band	1A	2A	3A	4	5	6	7	8	9	10
I_ν (MJy/sr)[a]	0.879	0.695	0.403	0.693	17.438	31.831	11.093	12.054	12.291	10.530
σ_{I_ν} (MJy/sr)[b]	0.005	0.011	0.006	0.006	0.181	0.330	0.052	0.144	4.931	2.141
Quality flag (Hex)	00	00	00	00	00	00	00	00	00	00

[a] `Photomet`
[b] `StdDev`

Also to facilitate software validation, Figure D.2-1 shows a one–dimensional "slice" through the 25 μm $\varepsilon = 90°$ Sky Map at fixed ecliptic longitude. Specifically, photometric data obtained prior to mission week 30 at ecliptic longitudes between 84 and 85° are selected and plotted as a function of ecliptic latitude using the following IDL commands:

```
IDL> wk30_time = 2.979072e+08      ;1990 day 162 in seconds since 1981.00
IDL> early_times = where(t81 lt wk30_time)
IDL> eclon = eclon(early_times) & eclat = eclat(early_times)
IDL> phot = phot(early_times)
IDL> select = where((eclon lt 85) and (eclon gt 84))
IDL> !x.title = 'ECLIPTIC LATITUDE (degrees)'
IDL> !y.title = '25 micron INTENSITY (MJy/sr)'
IDL> !p.title = 'FIGURE D.2-1: FIXED ECLIPTIC LONGITUDE SCAN (84<L<85 deg)'
IDL> plot, eclat(select), phot(5, select), psym = 4, yrange = [0,80]
```

[1] Data processing "Pass 3B" versions

Table D.2-2: Data for pixel 42 in Weekly Sky Map 22

File	DIRBE_WK22_WEEKLY_AVERAGED_SKYMAP.FITS
Time (T81)	293410493.389 s
PSubPos (Hex)	C8
SolElong	79°87
NumRecs	14
SSOFlag (Hex)	00

FracUsed (%)	Overall	Band 1B	Band 7
	76.1	100.0	71.4

Band	1A	2A	3A	4	5	6	7	8	9	10
I_ν (MJy/sr)[a]	0.892	0.734	0.416	0.830	19.617	34.749	11.365	12.046	10.631	2.529
σ_{I_ν} (MJy/sr)[b]	0.013	0.030	0.017	0.012	0.031	0.061	0.129	0.343	10.369	5.113
WtNumObs	8	13	11	9	13	12	10	6	13	11
DeltaT (hours)	3.281	5.906	3.281	12.469	3.281	−0.656	4.594	−11.156	−1.969	5.906
Displace (Hex)	C1			68			3F	6E		

Polarization in band	1		2		3	
	Q	U	Q	U	Q	U
Stokes	−16397	0.02	−16397	0.04	−16397	−0.06
StokesSD	0.	0.015	0.	0.038	0.	0.029

StokQual (Hex) **for band ratio**	1B/1A	1C/1A	2B/2A	2C/2A	3B/3A	3C/3A
	C0	40	C0	00	C0	00

[a] Photomet
[b] StdDev

Table D.2-3: Data for pixel 42 in the Annual Average Sky Maps

File	DIRBE_BANDx_ANNUAL_AVERAGE_SKYMAP.FITS for $x = 1A, 2A, 3A, 4, \ldots, 10$
Time (T81)	295732488.424 s
SumNRecs	303
PSubPos (Hex)	3E

Band	1A	2A	3A	4	5	6	7	8	9	10
I_ν (MJy/sr)[a]	0.903	0.723	0.419	0.735	18.0	32.1	10.9	11.5	15.7	11.4
σ_{I_ν} (MJy/sr)[b]	0.00719	0.00717	0.00455	0.0178	0.308	0.417	0.0895	0.0702	2.36	1.24
WtNumObs	202	213	210	223	211	205	186	154	222	221

[a] Photomet
[b] StdDev

Table D.2-4: Data for pixel 42 in the Solar Elongation = 90° Sky Maps

File	DIRBE_BANDx_ELONGATION90_SKYMAP.FITS for x = 1A, 2A, 3A, 4, …, 10
Time (T81)	294533016.795 s
EfNumObs	40

Band	1A	2A	3A	4	5	6	7	8	9	10
I_ν (MJy/sr)[a]	0.879	0.695	0.403	0.693	17.438	31.831	11.093	12.054	12.291	10.530
σ_{I_ν} (MJy/sr)[b]	0.005	0.011	0.006	0.006	0.018	0.033	0.052	0.144	4.931	2.141
FitQual (Hex)	00	00	00	00	00	00	00	00	00	00
χ^2	0.8	0.3	0.6	0.4	0.5	3.3	1.9	0.2	0.1	0.4

[a] Photomet
[b] StdDev

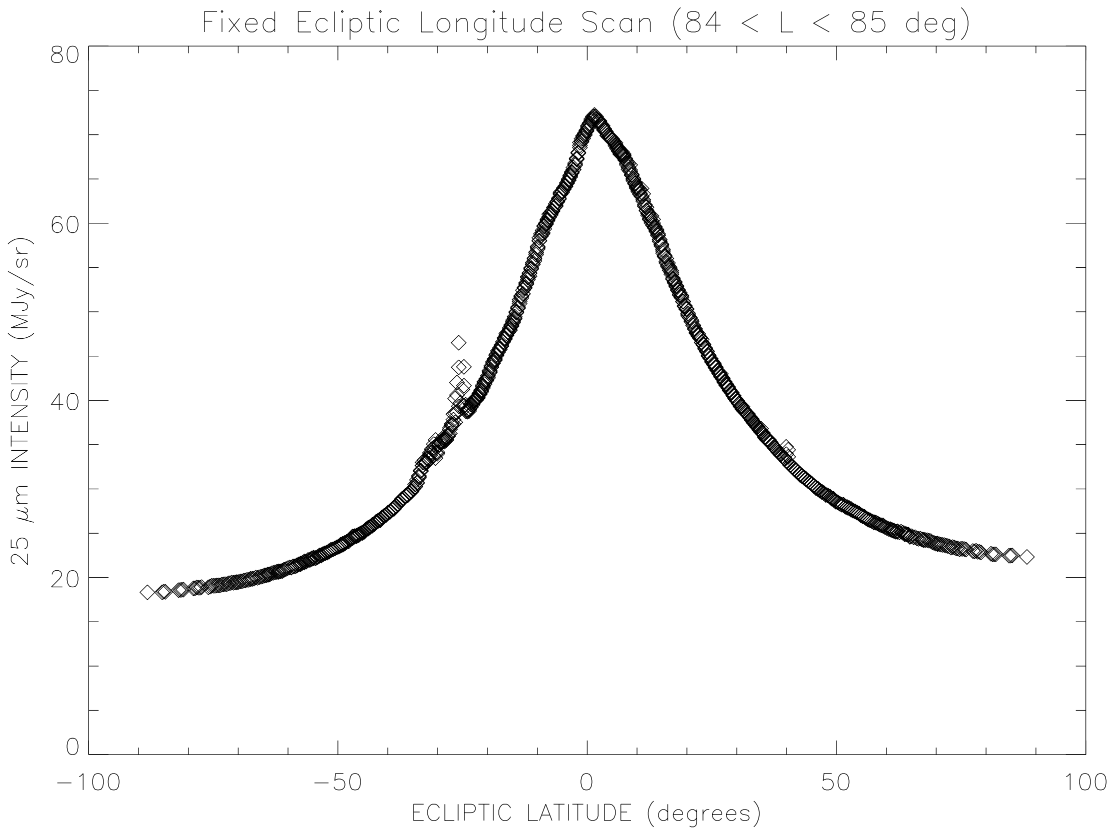

Figure D.2-1: A slice through the 25 μm $\varepsilon = 90°$ Sky Map at fixed ecliptic longitude.