Experience of the JPL

Exploratory Data Analysis Team

at Validating HIRS2/MSU Cloud Parameters

Ralph Kahn, Robert Haskins,
Stephanie Granger-Gallegos, and Andy Pursch

Jet Propulsion Laboratory, California Institute of Technology

and

Anthony Del Genio

Goddard Institute for Space Studies

Where We Began:

The Cloud/Climate Feedback Problem
Key Measurements Addressing the Cloud-Climate Feedback Problem

Microphysical parameters:

1. $\beta = \frac{d(\ln m)}{dT}$ dependence of cloud water (liquid and ice) content on temperature (including liquid to solid transition temperature and small ice particle concentrations)

2. $\gamma = \frac{d(\ln \tau)}{dT}$ dependence of cloud opacity on temperature (implicitly, $\frac{dr}{dm}; \frac{dr}{dT}$)

Cloud properties:

3. $n (q, w, T)$ dependence of cloud amount on relative humidity, vertical velocity, temp., and other environmental parameters

4. cloud top height dependence on temperature, relative humidity, vertical velocity, and and other environmental parameters

5. variability in cloud behavior (diurnal, seasonal, interannual; land & ocean)

Cloud-related processes:

6. distinguish $T$ from dynamical effects on clouds (sign & size of feedbacks)

7. determine large-scale conditions for formation and breakup of marine stratocumulus (Cloud Top Entrainment Instability)

8. determine the relationship between deep convection and upper troposphere water
SENSITIVITY OF DERIVED EFFECTIVE CLOUD AMOUNT TO SURFACE TEMPERATURE

\[
\left. \frac{\partial N}{\partial T_s} \right|_{p_0} = \frac{e_s e^{\tau_0} (1 - N) \frac{\partial B_v(T_s)}{\partial T_s}}{e_s B_v(T_s) e^{\tau_0} + R_s e^{\tau_0} + \int_{t_i}^{t_0} B_v(T') e^{-\tau'} dt' - B_v(T_c) e^{\tau_0}}
\]

On the right side, the terms in the denominator account for:

1. direct radiation from the surface
2. solar radiation reflected by the surface
3. emission of the atmosphere below the cloud level
4. emission from the cloud surface.

The terms are wavelength dependent.

The derived cloud amount is less sensitive to surface temperature for higher clouds. This occurs because as the cloud elevation increases, the difference between \( T_s \) and \( T_c \) increases, so only a small change in cloud amount is needed to effect a large change in radiance at the detector.
\[ \frac{\partial u}{\partial T} \mid _{\rho c} \] [window channel]
\[ \frac{\partial N}{\partial T_s} / \rho_0 \]  
(735 mb peak channel)
Definition of Validation

By 'Validation', we mean 'developing a quantitative sense for the physical meaning of the measured parameters', by:

(1) identifying the assumptions involved in deriving parameters from the measured radiances

(2) testing the input data and derived parameters for statistical error, sensitivity, and internal consistency

(3) comparing with similar parameters obtained from other sources using other techniques
Identifying the Assumptions

-- in the Measurements (instrument, technique)

-- in the Algorithm (retrieval equations)

-- in the Code ('if' statements)
GSFC HIRS2 Level 2 to 3 Software Overview / Assumptions

R. Kahn
last revised: 07/03/91

A

MAIN44
- initialize variables
- call subroutines

WRITE OUTPUT
(WRDATA)

B

SET UP VARIABLES
- select HIRS2 parameters and time intervals
  for processing (PROCESS_PARMS)
- set up variables (RDTOPO; INIT)

CALCULATE AVERAGES
for each parameter in each bin, and note
bins w/missing data (TIMAVG)

D

C

READ INPUT DATA
- read daily retrieval data from input
tape (RDAILY; PARSE_DATA)

EMIS TEMP CLASS
Land: > 0.9 — Dry Land
< 0.9 < 275 Snow
< 0.9 > 275 Moist Soil
Ocean: — > 275 Ocean
> 0.7 < 275 Ice
0.65 to 0.7 < 275 Ice / Water
< 0.65 < 275 Ocean
Ocean: TOPOG in bin <= 0

SET DAY / NIGHT FLAG
(DAYNITE)

SUM ALL THE DATA
- for the time period requested
- for each geographic bin
- for each parameter requested;
and accumulate the # of entries
(SUMDATA)

If temp is > 275, and emissivity < 0.9, and an/
surrounding bin is ocean, classify as Dry Land
rather than Moist Soil

C.2.1

Accumulate Day and Night
Surface Temperatures
(SUMTMP)

C.2.2

Accumulate Day, Night, and
Day + Night Ozone
(SUMOZO)

C.2.3

C.2.4

C.2.5

C.2.6

C.2.7

C.1

SET UP VARIABLES
- read daily retrieval data from input
tape (RDAILY; PARSE_DATA)

HIRS2/MSU
LEVEL 2 DAILY
PARAMETERS

Check: only allow:
- 90 <= Lat <= 90
- -180 <= Lon <= 180

Define day (not night) as:
8.5 to 20.5 local hours

Only include data from 'good' temp. retrievals:
IERR > 0
in averages of all parameters
EXCEPT CLOUDS

1. Only allow surf. temp:
200 < STEMP < 350

2. Reject data if temp. came from
climatology (if IERR = 2)

3. Reject data if retrieved SST
differs from climatology by
7 K or more

4. If the retrieved SST is
between between 5 and 7 K
greater (less) than
climatology, set SST to
climatology + 5 K (- 5 K)

Only allow ozone values
100 < OZONRT < 600
dobsons

Accept ozone value only if
measurement sensitivity is high
(1 deg change in H9 brightness
(O3SENS) changes ozone by
less than 50 dobscons).
Limits on min and max layer thickness not implemented

Only allow emissivity values: $0 < \text{SEMSI} < 1$

Reject data if water retrieval flag is bad (T_WATER < 0)

Reject data if obs and computed Tb in Channel 8 differ by more than 3 K (ABS (DIF8) > 3)

Reject data if obs and computed Tb in Channel 10 differ by more than 3 K (ABS (DIF10) > 3)

Limits on min and max temperatures at each level not implemented

1. All Cloud Fractions are the sum of Clr. Frs. reported for clrs. in 2 layers
2. Only allow clr. fract. values in layer 1: $0 \leq \text{CLFR4} \leq 1$
3. Reject data if the brightness temp. fit for 5 clr. retrieval channels (FIT) > 5 K, when layers 1 and 2 are included
4. Reject data if the need for clr. is small (RMSNO < 5), and 2-layer clr. correction doesn't help much (FIT > 2)
5. Set clr. = 0 if the need for clr. is small (RMSNO < 2), and 1-layer clr. correction doesn't help much (FITCK > 0.7)

Accumulate Layer Thicknesses for up to 12 layers (SUMTHK)

Accumulate Surface Emissivity from MSU Channel 1 (SUMEEMI)


Accumulate Temperature Profile Data at up to 20 Levels (SUMTRT)

Accumulate Day + Night, Day, and Night Total Clr. Fractions and Cloud Top Pressures, and High, Middle, and Low Clr. Frs., and albedo, in 4 quadrants (SUMCLD)

If albedo > 1, it is set to 1 (RATIO = 100.)

Skip albedo calculation if it is night (ANGSUN > 75)

Set clr. = 0 if (1) clr within 150 mb of surf., (2) fit is good w/o clr (RMSNO < 3), (3) clr fract > 0.4, and (4) window channel fits well (BTD < 2)

Set layer 2 clr = 0 if (1) layer 2 clr is within 100 mb of surf and layer 2 clr doesn't help the fit (FITCK > 0.9), or (2) layer 2 clr fract > 0.4 and FITCK > 0.95
HIRS2/MSU PHYSICAL RETRIEVAL:
OVERVIEW of CLOUD PARAMETER DERIVATION

A.1
CALCULATE \( \eta \)
(the cloud correction factor from two octants)

A.2
USE MICROWAVE TO CORRECT IR RADIANCES FOR CLOUD
- estimate the expected clear column radiances in IR channels H13 and H14 and microwave channel M2 using radiative transfer model initialized with first guess - use (observed - model) M2 to correct H13 and H14 for cloud

A.3
Solve:
\[ \eta = \frac{I_2(v) - \bar{I}_2(v)}{\bar{I}_1(v) - \bar{I}_2(v)} \]
using corrected clear-column radiances and observed radiances for H13 and H14.
(ETACLD)

A.4
1. Assume effective cloud amount, but not other cloud properties (particle properties, cloud pressure level), varies over two octants (about 60 km²).
2. Ignore cloud edge effects.
3. Assume the cloud IR reflectivity is zero.
4. Neglect differences in surface reflection between clear and cloudy conditions.
5. \( \eta \) is a weighted ave. of H13 & H14 values.
6. If \( \eta \) is cloudy (>4) and (warm - cold) is small enough (<8), set \( \eta = 4 \).
7. If \( \eta < 0 \), it is set to 0.
8. If (warm - cold) is small (<-1), and (clear - warm) is small (<-3), set \( \eta = -0.5 \) and call it clear.
9. The values (warm - cold) & (clear - warm) used to test \( \eta \) are obtained from either H13 or H14, or both. If the test value for a channel is small (<0.009), it is ignored. If both are small, H14 is used. To obtain \( \eta \) itself, both channels are always used.

A.5
FIND CLOUD CORRECTION LEVEL above which cloud effects are ignored.
(CLDCOR)

B.
Set \( \eta \) to 5; set ierr to -4.
SKIP TO SECTION C
For Ocean cases only, use First Guess Temperature Profile. For Land, reject data.

Use first guess temperatures

Level 1b Radiances:
4 x 4 HIRS2 spots + one overlapping MSU sounding

At least one octant must not be completely cloud covered.

Assume the octant with the warmest 11 µm brightness temp. is clearest.

If some soundings have land & others ocean flags in a 4 x 4 group, do one retrieval each over land and water.

First Guess Temp.
Profile from GCM & Climatology
(Constrains shape of the final profile.)

Assume M2 accurately sounds temperature in the same region as H13 and H14, and is not affected by liquid water drops and other opacity sources.

Determination of which channels get cloud corrections is done only on the first iteration of the retrieval.

No cloud correction is applied to the uwave channels.

For IR window channels (peak > 1000 mb), cld. corr. is always applied.

For IR channels sounding very high (peak < 275 mb), cld. corr. is never applied.

Apply cld. corr. for all channels from lowest up to the first for which (warm - cold) < 0.3

Corrected clear col. observed radiance is set to \( [\text{warm} + \eta \cdot (\text{warm - cold})] \)

For no correction, or if clear col. rad. <= 0, set clear col rad. to 0.5 * (warm - cold)
Assume the cloud amount ratio is independent of wavelength across the 4 and 14 μm bands, and is determined with the assumptions of A.3.

Neglect any cloud effects on the MSU channels.

FIND CLEAR COL. BRIGHTNESS TEMP. IN 7 CHANNELS (H2, H4, H13, H14, H15, M3, M4) for the 2 warmest octants, using η for cloud correction.

Assume a Lambertian surface, with emissivity for land areas of 0.85 at 4 μm, 0.98 at 15 μm; for ocean, it is taken as 0.95 at 4 μm, 0.98 at 15 μm.

Ignore any cloud effects on H8, H18, H19.

For night, take ave. of 3 separate surf. temp. determinations. For day, solve simult. for surf. temp. and reflectivity with H18 and H19.

Reject any derived temp. that deviates > 1.5 deg. from the mean of derived temps.

Use weighting to compensate for the size of water vapor (H8), reflected solar radiation (H18, H19 daytime obs.), cloud and other corrections when averaging surf. temp. values.

Use climatology for sea surf. temp. if (1) the spread in derived temps. is too large or (2) the final result deviates > 5 deg from climatology.

Only 3 or 4 iterations of the surface temp. section are allowed for each retrieval.

Assume climatology represents all the information about the shape of the clear column temperature profile not contained in 7 channels.

FIRST GUESS TEMPERATURE PROFILE

ITERATIVELY ADJUST THE TEMPERATURE PROFILE to fit clear column temperatures from 7 channels

1. RMS error > 1 or 2. calc. M2 brightness temp. deviates from obs. by > 1 deg.

Residuals large?

No

RETURN TO STEP A.2. Use most recently derived temp. structure instead of GCM and climatology inputs.

Yes
CALCULATE EFFECTIVE CLOUD AMOUNT AND EFFECTIVE CLOUD TOP PRESSURE

C1
CONSTRRAIN ATM. WATER VAPOR AND OZONE PROFILES
water: (H8, H10, H11, H12)
ozone: (H9)

Ignore any effects the derived water vapor might have on the derived temp. profile.

C2
CALCULATE LAYER 1 CLOUD PARAMETERS
(H4, H5, H6, H7, H8)

1. Assume the retrieved temp. structure applies to all four quadrants (about 125 km2).
2. Use the first guess temp. structure if the retrieval failed.
3. Assume the cloud IR reflectivity is zero.
4. Ignore cloud edge effects.
5. Neglect differences in surface reflection between clear and cloudy conditions.
6. Assume all cloud microphysical properties are independent of wavelength between 11 and 15 microns.
7. Assume effective cloud amount and cloud pressure, but not other cloud properties, vary over four quadrants.
8. Assume all clouds are physically thin (radiate at a single temperature), with well-defined cloud tops.
9. Constrain cloud pressure to fall between 950 mb and tropopause.
10. Report cloud parameters averaged over four quadrants.

C3
CALCULATE LAYER 2 CLOUD PARAMETERS

Assume the residuals from C.2 are associated with a second cloud level.
Assume there are clouds at two distinct levels.
Figure 3. Interactive Data Extraction and Analysis System
THE NEED FOR LEVEL 2 DATA

3 COLOR IMAGES SHOW HIRS2 JULY 1979 CLOUDS

(1) 2 X 2.5 DEGREE BIN,
(2) 500 X 500 KM BIN
AND (2) - (1)
Exploratory Data Analysis Activities

Select Parameters and Subsets
- temporal, error condition, and other sampling

Gridding

Level 2 (point) Data
Display
- sampling locations and statistics shown

Interactive Geographic Subset Selection

Subset Files
- HDF Format

Surface Fitting

Interactive Data Analysis Procedures

Output Files, and B & W and Color Hardcopy

Statistical Analysis Tools
- cluster & component analysis
- surface comparison algorithms
- time series and other analysis tools

IDL & NCSA image analysis tools

MacSpin & other virtual 3-D analysis tools

Data Desk Scatterplot Matrix & other statistical-graphical interactive tools
FIGURE A.6
WIGSS MENUS

EDIT
- Select Box
- Define New Box
- Select Previous Box
- Select Region
- Define New Region
- Select Previous Region
- Display Level 2 Data
- Zoom Box
  - Create Zoom
  - Hide Zoom Box
  - Show Zoom Box
- Remove Points
- Clear Display
- Reset

COLOR
- Select New Palette
- Select Default Palette
- Color Scale
  - Create Color Scale
  - Hide Scale
  - Show Scale

DISPLAY PARAMETERS
- Parameter 1
  - Data
  - Standard Dev.
  - Counts
- Parameter 2
  - Data
  - Standard Dev.
  - Counts
- Parameter 3
  - Data
  - Standard Dev.
  - Counts
- Parameter N
  - Data
  - Standard Dev.
  - Counts

TOOLS
- Thermodynamics
  - Dewpoint
  - Lift Cond. Level
  - H2O Mass Mix Ratio
  - Potent. Temp.
  - Sat. Mix. Ratio
  - Sat. Vapor Press.
  - Specific Humidity
  - Vapor Pressure
  - Virtual Temperature
- List Data
  - Level 3
  - Level 2
- Contour Plot
- Surface Plot
- Histogram
- Variogram
- Create Postscript Plot
  - with Region Outline
  - without Region Outline
- Build Procedure

FILE
- Open
- Close
- Save
  - Save Box
    - in Old Dir
    - in New Dir
  - Save Data
    - as Tabular
    - as HDF
    - as Both
  - Save Region
- Print
  - Postscript Plot
  - Session Log
- Quit

VIEW
- Session Log
- Box Info
- HDF File Desc.
- Intro Msg.
- Postscript Plot

HELP
- Help Menus
- Help Variables
- Help Procedures
- About WIGSS
**FIGURE A.7**

**BOX INFORMATION**
- **LAT RANGE:** -10.0 to 81.0
- **LOH RANGE:** 132.0 to 167.0
- **PARAMETER:** SRFC_TMP_RTR_LVL 0
- **DATA MINIMUM:** 232.259
- **DATA MAXIMUM:** 303.868

**Command:**
- Position cursor in space above, CLICK left button and enter a 3 to 8 Character Directory Name then RETURN
EDA HIRS2/MSU STANDARD DATA FILES PROCESSING

-- Problem of multiple machine architectures

We converted our data files to Hierarchical Data Format (HDF).

[Developed at NCSA (National Center for Supercomputer Applications)]

-- Problem of data documentation

[How are the fields stored, what do they mean (units, definitions, assumptions)?]

HDF solves a part of these problems (some information about 'data objects' is stored in HDF files)

What We Have Learned About Standard Data Handling Time Scales:

-- To discover the need for HDF, learn HDF, and apply it - ~ 1 year

-- Knowing what we now know, to rebuild from scratch - ~ 6 months

-- To create HDF files for a different data set, of comparable complexity, in an arbitrary format -
<~ 2 months, depending on the documentation and hardware availability

-- To ingest a different data set, of comparable complexity, that is already in HDF format -
~ 2 weeks to read data, test, and to study the documentation

For data analysis, the issue of assumptions is a large one, not addressed in the standard data processing (discussed later).
Partial List of Software That Automatically Reads Files in HDF Format

Currently Available:

<table>
<thead>
<tr>
<th>NAME</th>
<th>Platform</th>
<th>Source</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Scope</td>
<td>Mac</td>
<td>NCSA</td>
<td>Display, manipulate arrays &amp; images</td>
</tr>
<tr>
<td>Image Tool</td>
<td>Mac</td>
<td>NCSA</td>
<td>Display, animate image &amp; color bar</td>
</tr>
<tr>
<td>Layout</td>
<td>Mac</td>
<td>NCSA</td>
<td>Create presentation from images, text</td>
</tr>
<tr>
<td>Transform</td>
<td>Mac</td>
<td>Spyglass</td>
<td>Combines Data Scope &amp; Image Tool</td>
</tr>
<tr>
<td>Format</td>
<td>Mac</td>
<td>Spyglass</td>
<td>Similar to Layout</td>
</tr>
<tr>
<td>Dicer</td>
<td>Mac</td>
<td>Spyglass</td>
<td>Select &amp; view sections of 3-D display</td>
</tr>
<tr>
<td>X-Image</td>
<td>Sun*</td>
<td>NCSA</td>
<td>Combines Data Scope &amp; Image Tool</td>
</tr>
<tr>
<td>XDS</td>
<td>Sun</td>
<td>NCSA</td>
<td>Similar to Dicer</td>
</tr>
<tr>
<td>Reformat</td>
<td>Sun</td>
<td>NCSA</td>
<td>Convert FITS, TIFF, GIF, SUN, raw raster files, &amp; x-window dumps to HDF</td>
</tr>
<tr>
<td>APE 2.0</td>
<td>Sun</td>
<td>Ohio State</td>
<td>Object-oriented prog. language</td>
</tr>
</tbody>
</table>

In Development or Testing:

| IDL       | Sun      | RSI    | Interactive graphics prog. language         |
| IGSS      | Sun      | JPL/EDA| Interactive Geographic Subset Selection     |
| netCDF filter | Sun | NSF    | Convert netCDF to HDF                       |

* 'Sun' also runs on many other UNIX platforms, including Apollo, Alliant, Convex, Cray, DEC-ULTRIX, and IRIS Workstations.
HDF Software in an Integrated Computing Environment

Cray

libdf.a r8tohdf, hdfseq, ...

HDF files

libdf.a

Composite Tool

Image Tool

X Image

X DataSlice

hdfseq, r8tohdf, ...

hdfseq, r8tohdf, ...

PalEdit

Image

Layout

DamScope

Sun

Macintosh II
HDF File with
Scientific Dataset

<table>
<thead>
<tr>
<th>rank</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>dimensions</td>
<td>90 by 100</td>
</tr>
</tbody>
</table>
| data | 63.2, 54.5, 12.3, ...
|   | 18.2, 103.6, 7.4, ...
|   | 12.1, 8.9, 83.6, ...
| labels | data: "pressure", dim 1: "x vel", dim 2: "y vel" |
| units | data: "pascals", dim 1: "cm/sec", dim 2: "cm/sec" |
| formats | dim 1: "F10.6", dim 2: "F8.1" |
| scales | dim 1: 100, 200, 300, 400, 500, 600, 700, ... |
|   | dim 2: 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, ... |

FORTRAN:

```fortran
INTEGER DFSStdims, DFSStdatalstas, DFSStdimastas
INTEGER DFSStdimscale, DFSStdutdata
REAL pressi(90, 100), press2(90, 100)
REAL deni(90, 100), den2(90, 100)
INTEGER shape(2), ret
REAL xscale(90), yscale(100)

shape(1) = 90
shape(2) = 100

ret = DFSStdims(2, shape)
ret = DFSStdatalstas('pressure 1', 'Pascals', 'E15.9', '')
ret = DFSStdimastas(1, 'x vel', 'cm/sec', 'F10.6')
ret = DFSStdimscale(1, shape(1), xscale)
ret = DFSStdatalstas(2, shape(2), yscale)
ret = DFSStdutdata('SDeX1.hdf', 2, shape, pressi)

ret = DFSStdatalstas('pressure 2', 'Pascals', 'E15.9', '')
ret = DFSStdutdata('SDeX1.hdf', 2, shape, press2)

ret = DFSStdclear()
ret = DFSStdatalstas('density 1', 'g/cm3', 'E15.9', '')
ret = DFSStdutdata('SDeX1.hdf', 2, shape, deni)

ret = DFSStdatalstas('density 2', 'g/cm3', 'E15.9', '')
ret = DFSStdutdata('SDeX1.hdf', 2, shape, den2)
```
HIRS2/MSU HDF LABEL

FILE IDENTIFIER LENGTH: 5
FILE IDENTIFIER: LABEL
FILE DESCRIPTOR LENGTH: 1831
FILE DESCRIPTION:
Description: HIRS2/MSU parameters retrieved using the Goddard Laboratory for Atmospheres (GLA) Physical Inversion Algorithm Baseline 4.0. They are stored as individual objects of an HDF file. These files are the standard data source for most data analysis applications. Most of the parameters delivered on the original GSFC tapes are included. The following parameters were eliminated (either because of questions about definition, redundancy, or problems of interpretation of the values): tau; diat; dlon; np; cldht; cldfr; retwat(1); retwat(5); humret(13); rthick. Thirty seven parameters remain. They are listed and defined in /edal/doc/hirs_daily/rec.doc.

Level 2 data for: 06 jul 79, 02 - 242. Platform: TIROS-N


Contact: Robert Haskins
Jet Propulsion Laboratory
Mail Stop 183 - 301
4800 Oak Grove Dr
Pasadena, CA 91109-8001

(818)354-6893

Regional Boundaries are: Global

Number of Parameters: 37

Parameters:
YMMDD, HHHHSS, QUADLATS, QUADLONS, DNFLAG,
LANDWTR_FLAG, SAT_ZEN_ANGLE, GEOPOT_THICK,
HIRS8_OBS, VIS_RELECTANCE, SRFC_EMIS_PW, SRFC_PRES
TROP_PRES_RTR, SRFC_TMP_RTR, SST_ANOMALY,
TMP_PROFILE_RTR, QUAD_NUM_TMPS, QUAD_FLAG,
TMP_RTR_FLAG, TB_RESIDUAL, TB_RMS_TMP,
RHUM_PROF_RTR, PRECIP_WTR, WATER_FLAG, TB_RMS_WTR,
HIRS8_TBDIF_WTR, HIRS9_TBDIF_WTR, CLOUD_EFRAC_L1,
CLOUD TOP_PRES_L1, CLOUD_EFRAC_L2, CLOUD TOP_PRES_L2,
RMS_ERR_INCCLD, RMS_ERR_PRECLD, CLOUD_CLEAR_PARM,
HIRS8_TBDIF_CLD, OZONE_RTR, O3SENS

Comments:
Binary HDF file creation date: Mon Nov 4 16:42:31 EST 1991
Binary HDF file created on a CRAY Y-MP

SDS COUNT: 37
SDS DATA DIMENSIONS: 4 x 44821
SDS DATA LABEL: QUADLATS
SDS DATA UNITS: Degrees
SDS DATA FORMAT: F6.2
HDF OBJECT REFERENCE NUMBER: 9
HDF OBJECT DESCRIPTION:
Latitudes of four individual quadrants for cloud retrieval

--- Original Name = FLAT ---

SDS DATA DIMENSIONS: 4 x 44821
SDS DATA LABEL: QUADLONS
SDS DATA UNITS: Degrees
SDS DATA FORMAT: F7.2
HDF OBJECT REFERENCE NUMBER: 12
HDF OBJECT DESCRIPTION:
Longitudes of four individual quadrants for cloud retrieval.

--- Original Name = FLON ---

SDS DATA DIMENSIONS: 1 x 44821
SDS DATA LABEL: TMP_ERR_FLAG
SDS DATA UNITS: N/A
SDS DATA FORMAT: I3
HDF OBJECT REFERENCE NUMBER: 57
HDF OBJECT DESCRIPTION:
Error flag for temperature retrieval.

Positive IERR means successful
temp retrieval and retrieved temp
was used for water, ozone, and
cloud retrieval.

Negative IERR means temp
retrieval failed and first guess
temp and moisture is used in
subsequent cloud retrieval.

1000+K Converged on Kth iteration in retrieval
This parameter is always stored as 1 on
the tapes that we receive from GSFC.

1100 Did not converge after 9 iterations.
This parameter is always stored as 1
on the tapes that we receive from GSFC
(The information about whether or not
the retrieval converged is lost.)

2 SST retrieval was not attempted
over ocean, climatology SST is used.

3 Residual for HIRS2 channel 2 was large.
Ignore retrieved temperatures above 200 mb.

-4 Cloud clearing was not attempted;
too cloudy to do a retrieval.

-5 Big (1 degree) RMS on Tb residual
in temp sounding channels, or
in MW2 channel.

-6 Not used.
EDA HIRS2/MSU STANDARD DATA FILES PROCESSING

Hierarchical Data Format

We have developed software that:

1. Automatically moves HIRS2/MSU physical retrieval data from the IBM tape archive to the GSFC Cray

2. Automatically converts the data into HDF format, including adding file labels and detailed parameter descriptions

3. Automatically transfers the HDF files to a user-specified remote node via the FTP utility

We also have some standard utilities, and there is software in development, that takes HDF files and displays HDF label information creates floating point image data from HDF vector data displays floating point image HDF files and performs several kinds of analysis
EDA HIRS2/MSU STANDARD DATA FILES PROCESSING

DATE2TAU
(runs on GSFC Cray)
- Accepts user-specified time for requested data
- Converts time to internal clock time (tau)

HIRS2HDF
(runs on GSFC Cray)
- Accepts user request
- Obtains retrieval data from IBM archive
- Creates file header and documentation
- Converts IBM data files to HDF
- Transfers HDF files to remote node

IBM Tape Archive List
- obtain desired tape name and number from lookup table using internal clock time (tau)

HIRS2 / MSU IBM Tape Archive (GSFC)
- binary IBM records

H2_PARM_SELECT
(runs on remote UNIX node)
- user selects desired parameters
- error checking (currently uses the standard GSFC error checking)

HIRS2 / MSU HDF-SDS PARAMETER FILES
(resides at remote node)
- most parameters from IBM tape archive, translated to HDF.
  Name: mmmddyy.t.df

HIRS2 / HDF ARCHIVE
25 MB/day
(medium TBD - CD ROM possible)

HIRS2 / MSU HDF SELECTED PARAMETER FILES
- contains lat, lon, time, and param values (with related flags where appropriate)
- working files - reside temporarily on remote node
- user selected parameters & dates

FTP over TCP/IP net

last revised: 11/12/91
HIRS2/MSU
HDF SELECTED PARAMETER FILES
- contains lat, lon, time, and param values (with related flags where appropriate)
- working files - reside temporarily on remote node
- user selected parameters & dates

FILTERIO
[In Development]
(runs on remote UNIX node)
- allows user to select first-order processing
- writes out new HDF image-vector file or adds to an existing one

GRIDIT
- gridding

MEDIAN
- finds medid data value

SPATIAL
- averaging

FINDBIN
- bin average & bin count/day/month

RANSAMP
- random sampling

GRADSAMP
- gradient sampling

ARBSAMP
- arbitrary sampling

ZONEAVE
- zonal average

HDF IMAGE/VECTOR FILES
file contains:
- float images of param values, counts, & standard deviation for user-selected grid of cells
- vectors of lat+lon, time, param value, & connectivity list
SUMMARY

Validation Issues

Statistical characterization of data sets

Finding statistics that characterize key attributes of the data sets

Defining ways to characterize the comparisons among data sets (Scale issues, statistics,...)

Selection of specific intercomparison exercises

Selecting characteristic spatial and temporal regions for intercomparisons

Impact of validation exercises on the logistics of current and planned field campaigns and model runs

Preparation of data sets for intercomparisons

Characterization of assumptions

Transportable data formats

Labeling data files

Content of data sets

Data storage and distribution (EOSDIS interface)