

# **CERES Data Management System**

**Items for Discussion - September, 1995**

**Schedule**

**Working Group Status - Subsystem development**

**Science Computing Facility Status**

**Validation Tools**

**Near-term Plans**

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LANGLEY RESEARCH CENTER

APPROVAL: \_\_\_\_\_  
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ACCOMPLISHMENT \_\_\_\_\_  
D.C. Atheam

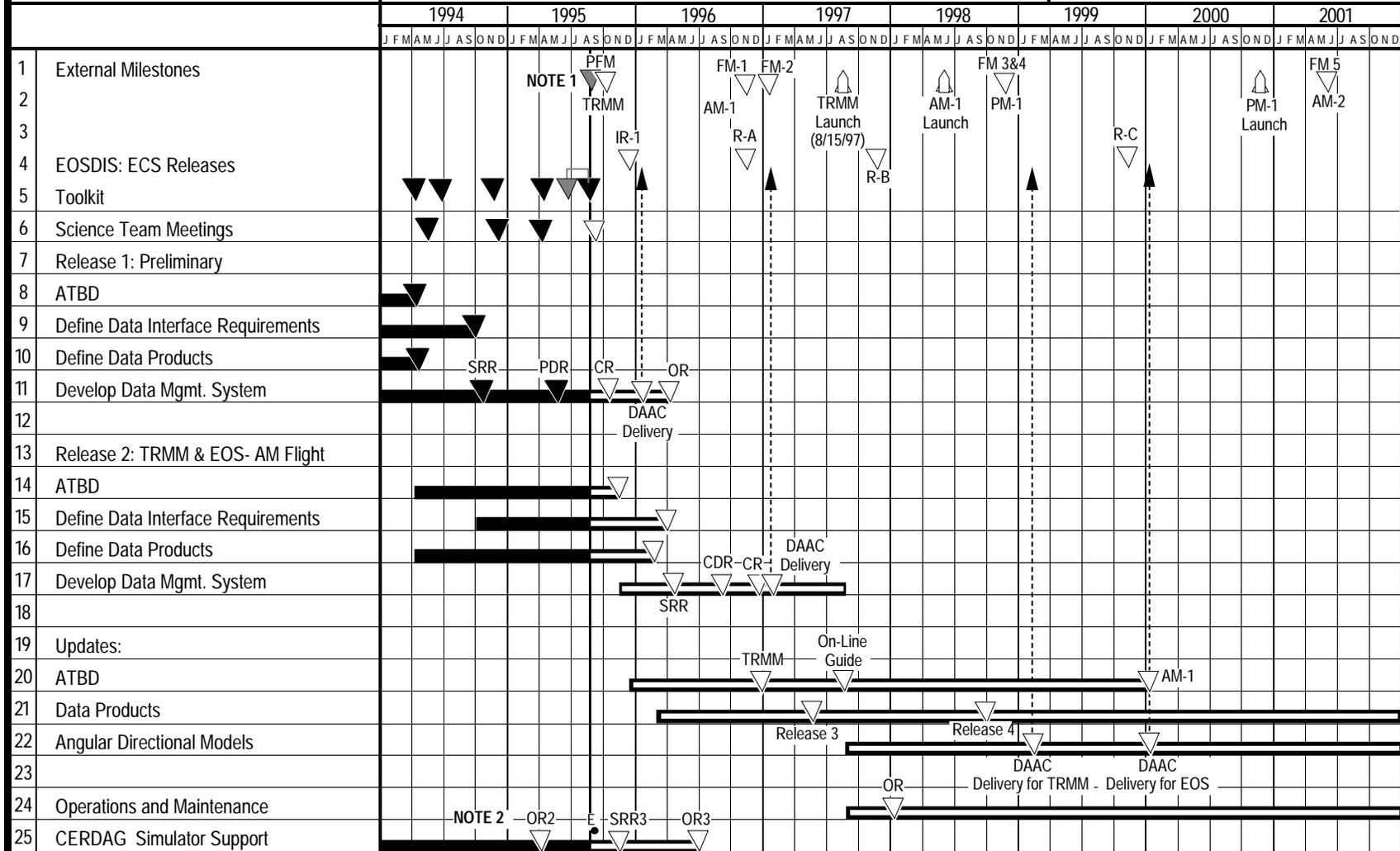
# CERES Data Management System Development

LEVEL

ORIGINAL SCHEDULE APPROVAL 10/8/92

LAST SCHEDULE CHANGE \_\_\_\_\_

STATUS AS OF 8/23/95



NOTES:  
 (1) TRW delivery of PFM to GSFC rescheduled from 9/15 to 10/16/95. Delay is due to expected late completion of PFM and later required need date for spacecraft integration at GSFC.  
 (2) Simulator delayed to the E to include latest changes from TRW instrument measurement analysis (DRL-64).

KEY:  
 CDR: Critical Design Reviews  
 CR: Code Reviews  
 ATBD: Algorithm Theoretical Basis Documents

▼ Baseline

OR: Operations Reviews  
 SRR: Software Requirements Reviews  
 PDR: Preliminary Design Reviews

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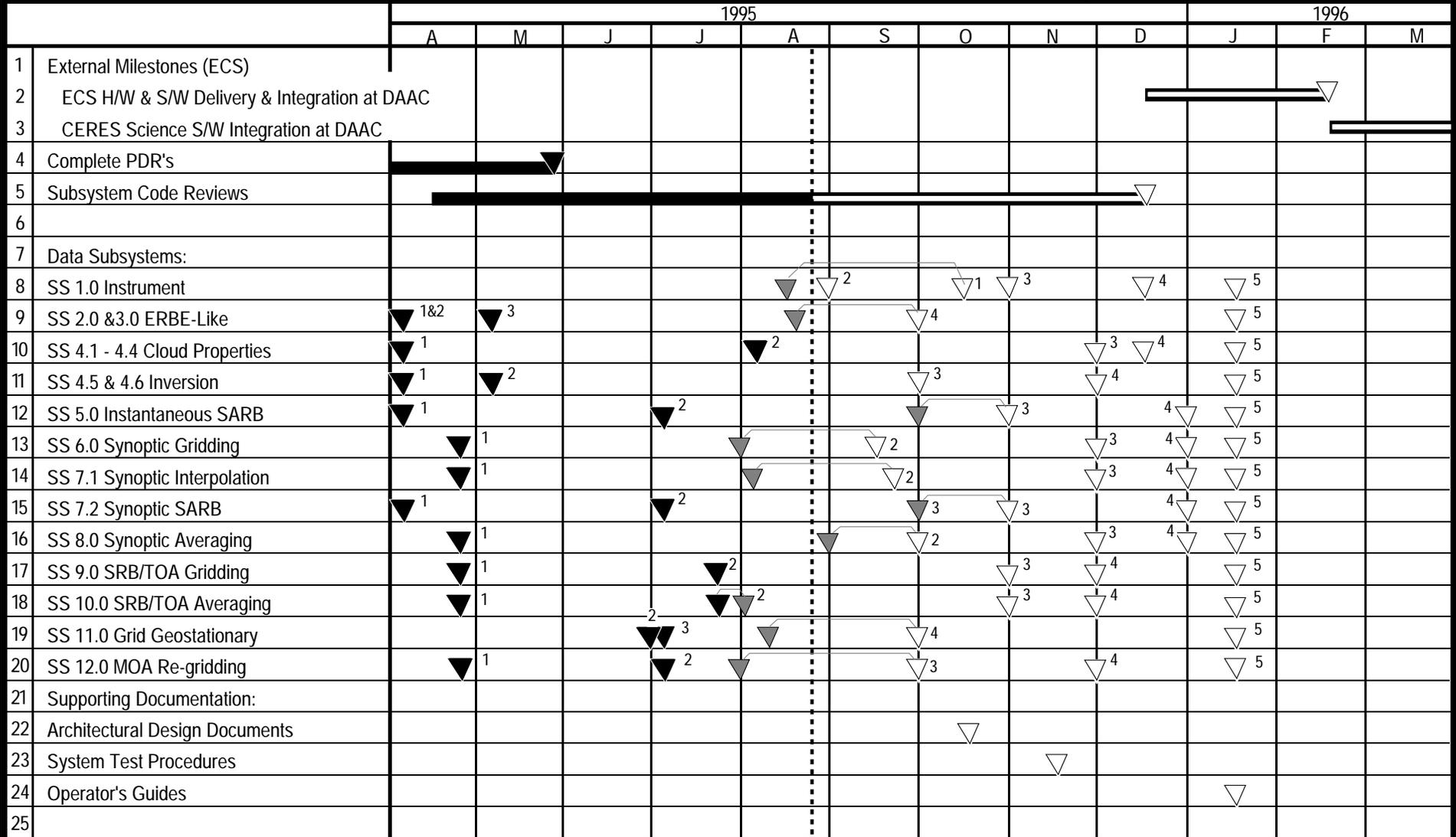
# CERES

## Data Management System Development Release 1 Integration & Test

ORIGINAL SCHEDULE APPROVAL \_\_\_\_\_

LAST SCHEDULE CHANGE \_\_\_\_\_

STATUS AS OF 8/23/95



NOTE: Milestones #1-4 are baselined while #5 milestone will be baselined later to completion dates from February 15 to August 15, 1996.



- Footnotes:**
1. Identify & Acquire Simulation Ancillary Data Sets
  2. End-to-End Interface Testing
  3. Test Subsystems with Science Algorithms
  4. "Thunder" (SCF) Integration
  5. CERES Del. for DAAC Integration

## **CERES Instrument Simulator**

**Processor simulation for validation of re-programming and in-flight anomaly investigation**

- **Circuit cards populated with sockets at LaRC Fab shop - 6/95**
- **Enclosure for system electronics ready for assembly & integration - 7/95**

**Current Status:**

- **Host-PC cards: I/O cards to support Matlab/Simulink received**
- **Host-PC Software: Will use TRW GSE & Matlab with Simulink**
- **TRW circuit cards from Cirtech: Now socketed, awaiting memory adaptor SMT connectors**
- **Chips to populate circuit card sockets: 99 % received**
- **1553 interface : PC host card is delivered, 78 pin SMT flatpack chip is on S/C I/O card**
- **Simulator hardware being integrated & tested in Bldg. 1250 lab**
- **Software simulation developed using Matlab to show commanded state of:**
  - **Azimuth Drive**
  - **Elevation Drive**

**Near-term Plans:**

- **Upgrade Host-PC**
- **Interconnection & packaging of cards & commercial components in enclosure**
- **SRAM memory adaptors now being designed for processor & S/C interface cards**

## **Working Group: Instrument**

### **Responsible for:**

- **Subsystem 1 (Instrument Geolocate and Calibrate Earth Radiances)**

### **Data Products:**

- **BDS (Bi-Directional Scan)**
- **IES (Instrument Earth Scan)**

### **Current Status:**

- **Preliminary design review held 4/14/95**
- **Detailed design for three of four Release 1 builds being developed in parallel**
- **Twelve code walkthroughs held to date**
- **Builds 1, 2, and 3 are 95%, 40%, and 20% complete respectively**
- **Data products implemented in HDF**

### **Near-term Plans:**

- **Continue with build plan**
- **Complete simulation of Level-0 CERES data from actual ERBE data**
- **Integrate and test geolocation and calibration algorithms**

## **Working Group: ERBE-Like**

### **Responsible for:**

- **Subsystem 2 (ERBE-like Inversion to Instantaneous TOA Fluxes)**
- **Subsystem 3 (ERBE-like Averaging to Monthly TOA Fluxes)**

### **Data Products:**

- **ES-8 (Equivalent to ERBE Instantaneous TOA Estimates)**
- **ES-9 (Monthly Averaged Regional Parameters)**
- **ES-4, ES-4G (Monthly Averaged Regional, Zonal, Global Parameters by region and gridded)**
- **Scene ID Ancillary Input Data, Spectral Correction Ancillary Input Data**
- **Solar Declination values for each year, Albedo Directional Model values**

### **Current Status:**

- **Execution scripts to run daily and monthly processes were completed and tested**
- **Release 1 code uses the ERBE 2.5 degree equal-angle grid system**
- **Except for TK5.0 implementation and testing, the Release 1 software is ready for delivery to the DAAC**

### **Near-term Plans:**

- **Port all ERBE-like code to DAAC-compatible machine for testing after installation of TK5.0 software**

## **Working Group: Clouds**

### **Responsible for:**

- **Subsystem 4.1 - 4.3 (Clear/Cloud Detection, Cloud Layers, Optical Properties)**
- **Subsystem 4.4 (Convolution with CERES Footprint)**

### **Data Products:**

- **SURFMAP (Surface Map and Properties) and MWP (Microwave Water Path)**
- **VIRS & MODIS & AVHRR (Cloud Imager Data)**
- **CRH (Clear Reflectance/Temperature History)**
- **CookieDough, CloudVal, FOOTPRINTVal**
- **Intermediate SSF (Single Satellite Footprint, TOA and Surface Flux, Clouds)**

### **Current Status:**

- **Production code Preliminary Design Review held 5/95**
- **IES simulated from ERBE data completed 8/95**
- **Production framework code and end-to-end test completed 8/95**
- **60% code peer review complete**

### **Challenge:**

- **Validation of submitted science code results**

### **Near-term Plans:**

- **Move more science algorithms from prototype to production code**
- **Add QC reports and science error messages to production code**
- **Complete integration and test milestones and prepare DAAC delivery package**

# Cloud Retrieval Prototype

Prototype allows early integration & testing of submitted algorithms

Current Status - Algorithm integration complete for:

- SERCAA Cloud Mask - Qing (LESC Hampton)
- Polar Snow/Ice Classification - Welch (South Dakota School of Mines)
- Classification - Baum (NASA LaRC)
- Aerosol - Stowe (NOAA)
- VINT - Minnis (NASA LaRC)
- Cloud Properties Algorithm - King/Platnick (NASA GSFC)

Current Status - Science Results

- Prototype with VINT and FOOTPRINT processed 2 hours of AVHRR data 9/95
- CookieDough, CloudVal, and Pre-SSF Hours 03 and 05 October 1, 1986 available
- Prototype ported to Thunder

Near-term Plans:

- Integrate Fire/Smoke/Fog/Dust Classification - Welch (South Dakota School of Mines)
- Produce more hourly data sets for algorithm validation
- Transition united team to production code

## **Working Group: Inversion and Surface Estimation**

### **Responsible for:**

- **Subsystem 4.5 (CERES Inversion to Instantaneous TOA Fluxes)**
- **Subsystem 4.6 (Estimate Longwave and Shortwave Surface Radiation Budget)**

### **Data Product:**

- **Archival SSF (Single Satellite Footprint, TOA and Surface Flux, Clouds)**

### **Current Status:**

- **Inversion software processed one hour of data obtained from Subsystem 4.4**
- **Finishing first cut of Release 1 Inversion software**
- **Coding Surface Estimation software**

### **Near-term Plans:**

- **Integrate Toolkit into existing code**
- **Finish Surface Estimation software**
- **Test software on thunder**
- **Prepare for DAAC delivery and integration**

# **Working Group: SARB - Surface and Atmospheric Radiation Budget**

## **Responsible for:**

- **Subsystem 5 (Compute Surface and Atmospheric Fluxes)**
- **Subsystem 7.2 (Synoptic Flux Computation)**
- **Subsystem 12 (Regrid Humidity and Temperature Fields (NMC))**

## **Data Products:**

- **CRS (Single Satellite Footprint, and Radiative Fluxes and Clouds)**
- **SYN (Synoptic Radiative Fluxes and Clouds)**
- **MOA (Meteorological, Ozone, and Aerosol)**
- **MWH, APD, GAP, OPD External Ancillary Data Inputs**

## **Current Status:**

- **Software to convert NMC temperature and humidity data to conform with CERES grid has been prototyped, used to provide data for testing science algorithms, and is being incorporated into Subsystem 12**
- **Ozone and aerosol climatological data have been incorporated into Subsystem 12**
- **Software to handle I/O operations on products passed between subsystems has been developed**
- **Developing software for Subsystems 5 and 7.2 that will interface with the radiative transfer code provided by Drs. Fu and Liou**

## **Challenges:**

- **Size of the MOA product - 25MB per hour**
- **The prototype code pushes the memory limits of the machine during execution**

## **Near-term Plans:**

- **Complete code development for all three subsystems**
- **Deliver completed software to the DAAC**

# Working Group: TISA - Time Interpolation and Spatial Averaging

## Responsible for:

- Subsystem 6 (Hourly Gridded Single Satellite Fluxes and Clouds)
- Subsystem 7.1 (Time Interpolation for Single and Multiple Satellites)
- Subsystem 8 (Compute Regional, Zonal and Global Averages)
- Subsystem 9 ( Grid TOA and Surface Fluxes)
- Subsystem 10 (Compute Monthly and Regional TOA and SRB Averages)
- Subsystem 11 (Grid Geostationary Data)

## Data Products:

- FSW - Hourly Gridded Single Satellite Fluxes and Clouds (Subsystem 6)
- SYN - Synoptic Radiative Fluxes and Clouds (Subsystem 7)
- AVG, ZAVG - Monthly Regional, Zonal and Global Radiative Fluxes and Clouds (Subsystem 8)
- SFC - Hourly Gridded Single Satellite TOA and Surface Fluxes (Subsystem 9)
- SRBAVG - Monthly Regional TOA and SRB Average, 1.25 Grid (Subsystem 10)
- Ancillary Data Products: ISCCP Geostationary Data

## Current Status:

- 12 code reviews held to date
- Coded: Grid ISCCP Geostationary Data
- Coded and reviewed: Data modules for SRBAVG, TSI, AVG/ZAVG, SFC
- Coded and currently reviewing: Temporal Averaging, Regional for SS10; Spatial Averaging, Build 1 for SS9
- Coded: Data module for FSW
- Coding Zonal/Global Averaging for SS10 and Secondary Index module for SS7.1
- Designing SS6, SS7.1, and SS8

## Near-Term Plans:

- Add temporal interpolation to SS10 averaging code, complete zonal and global averaging for SS10
- Modify SS10 code to create SS7.1 and SS8
- Modify SS9 code to create SS6

## Science Computing Facilities

- **Upgrading the SGI Power Challenge for end-to-end testing:**
  - **Eight R8000 MIPS processors running at 1 gigaflop**
  - **1.5 Gigabyte of memory**
  - **Installing 81GB of disk space for data product storage during processing**
  - **IRIX 6.1 operating system upgrade completed**
  - **SGI Fortran 90 has been installed**
  - **Planning to install SGI Verdix Ada**
  - **PGS Toolkit 5 on hold waiting resolution of installation problems**
  - **Investigating mass storage options (tape stacker or optical jukebox)**
  - **Sizing system configuration to support full one-month test of all subsystems**
- **120GB tape stacker for workstation backups/archival installed and tested, but need management software**
- **Installed 130GB optical jukebox - coordinating with DAAC for interface software**
- **EOSDIS standardized on IDL for graphics and analysis - installing on all CERES servers**

## Estimated Size of Intermediate and Archival Data Products

Working Group	Subsystem	Total I/O Per Run, MB	Archived Per Run, MB	Runs per Data Month	Archived per Data Month, MB
Instrument	1.0 Geolocate and Calibration	1546	627	31	19437
ERBE-Like	2.0 Inversion to TOA	903	276	31	8550
	3.0 Averaging to Monthly TOA	676	574	1	574
Clouds	4.1 - 4.3 Cloud Property Retrieval	1016	14	744	10416
Inversion	4.4 Footprint Convolution	1006		744	
	4.5 - 4.6 TOA and SRB Estimation	678	324	744	241056
SARB	5.0 Surface and Atmospheric Fluxes	857	439	744	326616
	7.2 Synoptic Flux Computation	214	66	248	16368
	12.0 Regrid MOA Fields	32	30	744	22320
TISA	6.1 Hourly Fluxes and Clouds, Gridding	493		744	
	6.2 Hourly Fluxes and Clouds, Region Sort	12420	6210	1	6210
	7.1 Single/Mult Satellite Time Interpolation	6823	54	248	13392
	8.0 Regional, Zonal and Global Averages	802	733	1	733
	9.1 TOA and Surface Fluxes, Gridding	361		744	
	9.2 TOA and Surface Fluxes, Region Sort	6250	3125	1	3125
	10.0 Monthly and Regional TOA and SRB	4814	1129	1	1129
	11.0 Grid Geosynchronous Data	1466	524	1	524
Total		40357	14125	5772	670450

## Estimated Source Code for each PGE

Working Group	SS	PGE	Source Code Lines	Number of Modules	Average Module
Instrument	1.0	Instrument	30000	50	600
ERBE-like	2.0	EINV	4200	40	105
	3.0	EDDBINT	330	9	37
	3.0	EDDBUPD	1200	21	57
	3.0	EDDBUER	580	11	53
	3.0	EDDBSRT	660	15	44
	3.0	EMTSA1	4000	60	67
	3.0	PREMTSA	1430	31	46
	3.0	EMTSA3	4000	60	67
	3.0	PRES4	540	12	45
	3.0	ES4	2870	48	60
			Total	19810	307
Clouds	4.1	Cloud Retrieval	27500	650	42
Inversion	4.4	Footprint Convolution	2500	53	47
	4.5	TOA/Surface Fluxes	7200	34	212
			Total	9700	87

## Estimated Source Code for each PGE

Working Group	SS	PGE	Source Code Lines	Number of Modules	Average Module
SARB	5.0	Instantaneous SARB	1900	12	158
	7.2	Synoptic SARB	1950	40	49
		SARB Shared Routines	3550	5	710
	12.0	MOA Regridding	11550	36	321
	Total			18950	93
TISA	6.0	Atmospheric Gridding	6000	120	50
	7.1	Gen Solar Declination	460	7	66
	7.1	Interpolate Synoptic	11000	52	212
	7.1	Merge Satellites	8000	40	200
	8.0	Gen Weights & Flags	1500	5	300
	8.0	Synoptic Averaging	12400	59	210
	9.0	Surface Gridding	6000	150	40
	10.0	Regional Averaging	16900	76	222
	11.0	Grid Geostationary	6000	120	50
	Total			68260	629
System		CERESlib & Utilities	5000	50	100
System Total			179220	1866	96

# **Status of ERBE Nonscanner Instruments**

**September 1995**

## **ERBS**

- **Continues to make science data measurements with periodic power off for yaw maneuvers.**
- **Internal and solar calibrations performed every two weeks, before and after power off events, and before and after full Sun periods.**

## **NOAA-9**

- **Continues to make science data measurements. WFOV SW heatsink temperature uncontrolled since Dec. 29, 1992.**
- **Loss of one battery and ability to send data in GAC format August 2, 1995. Data now sent in STIP format.**
- **Internal and solar calibrations performed every four weeks. Additional solar measurements made weekly.**

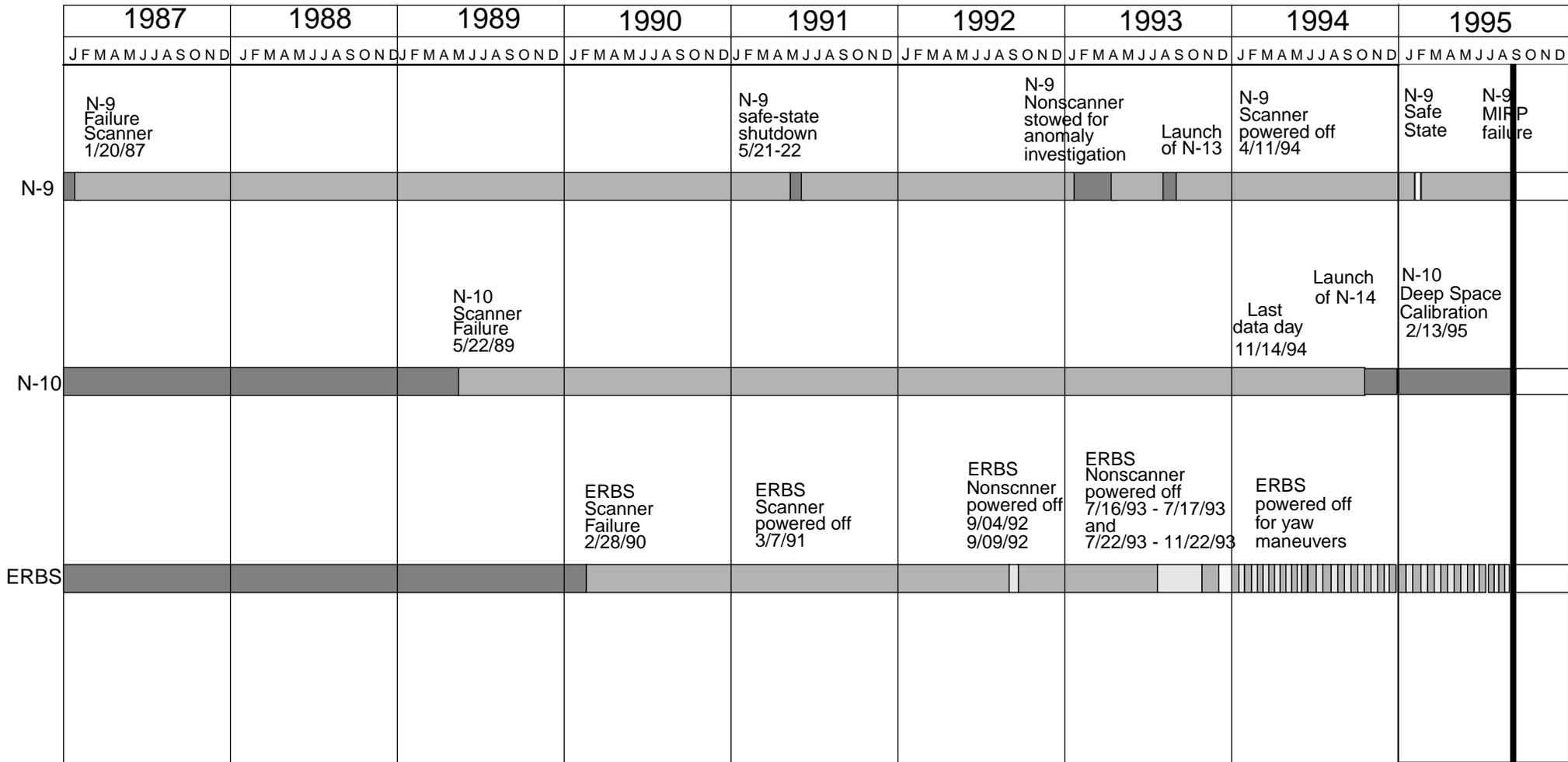
## **NOAA-10**

- **No longer supported by NOAA. Nonscanner instrument continues to operate; no data transmitted to ground stations.**
- **Spacecraft interrogated weekly by NOAA.**

## **Reprocessing consistent set of archival data from launch to present at Langley DAAC**

- **114 of 323 months of single-satellite daily and monthly products have been processed and archived**
- **27 of 108 months of combined-satellite monthly products have been processed and archived**

# ERBE NONSCANNER-ONLY OPERATIONAL SUMMARY



Legend

- |   |  |
|---|--|
| <p> Both scanner and nonscanner instruments operating</p> <p> Nonscanner instrument operating, data good*</p> | <p> Nonscanner instrument operating, data bad or unavailable</p> <p> Nonscanner instrument not operating</p> |
|---|--|

\*Good means we can process the data.

## **Validation and Visualization Aids**

**Develop tools for visualizing CERES data products to assist software development and support production processing and validation - understand the data and identify discrepancies**

### **Tools and Current Status:**

- **Multi-channel color strip charts for quick look at 'raw' data (OpenGL)**
  - **Processed one hour of CERES simulated SSF**
- **Latitude-longitude global plots for big picture initial look (NCAR graphics)**
- **ERBE production displays (IBM Data Explorer - LaRC Data Visualization Lab)**
  - **Prototyped using ERBE S-4G monthly products in HDF format**
- **FAST (Flow Analysis Software Toolkit - used in CFD community)**
  - **Modified to input CIA map database**
  - **2D projections (Mercator, Lambert Cylindrical, Orthographic, many others)**
  - **3D globe projection with interactive inspection**
  - **Modified to input CERES simulated SSF**

### **Near Term Development:**

- **Develop GUI interface for visualization tools**
- **Develop interfaces for all archival and validation products**
- **Enhancements to FAST:**
  - **Input NAVY 59 ecosystem and elevation maps**
  - **Support for unstructured data (Cloud, SARB, & TISA gridded products)**

## Validation Logistics

- On ERBE, there were many instrument and algorithm anomalies which we had to resolve.
  - For example, the scanner 'striping' problem took over six months to identify the problem, postulate a cause, develop a correction algorithm, and implement it into the production code
- We must use workstations and networks to improve our processes for identifying and correcting problems. Reduce the cycle for anomaly resolution from months to days. A scenario...
  - Brooks notices a strange repeating pattern near sunrise on each orbit. He cuts an image from his screen and sends it via e-mail to Bob.
  - Bob notes that the Sun is impinging on the satellite, plots a time-series of instrument temperatures which correlate, and forwards the results to Dominique.
  - Dominique uses his web viewer to retrieve flight data for testing a correction term as a function of beta angle.
  - Joey ftp's a corrected algorithm from Dominique, pastes the new terms into the production software, and e-mail's test results to Brooks.
- Can we settle on a small number of data interchange formats which are compatible?
  - EOSDIS is pushing HDF for archival data products
  - GIF for images?
  - PDF and/or Postscript for documents?
  - E-mail attachments???

## **Near-Term Plans**

- **Complete Release 1 science algorithm implementation and testing on SCF**
- **Deliver Release 1 code and test data sets to LaRC DAAC for integration and testing**
- **Begin definition of requirements for Release 2 - the TRMM flight processing system**