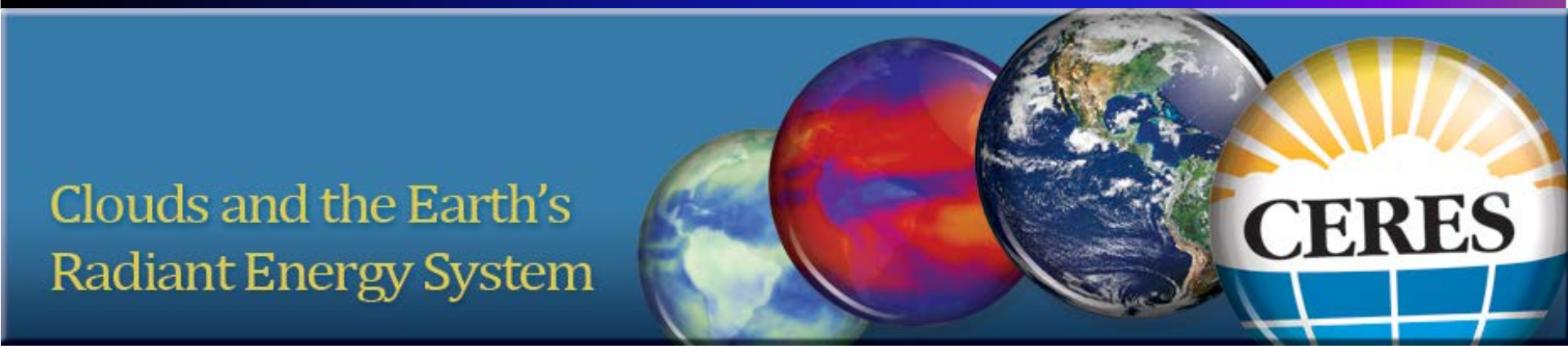


CERES FM6 and Follow-on Instrument Status Report

Kory Priestley
&
Instrument Working Group

CERES Science Team Meeting
Newport News, VA
May 1, 2012

Instrument Working Group Personnel

Science

- Susan Thomas -
Audra Bullock
Janet Daniels
Phil Hess
Suzanne Maddock
Mohan Shankar
Nathaniel Smith
Nitchie Smith
Peter Szewczyk
Robert Wilson

Data Management

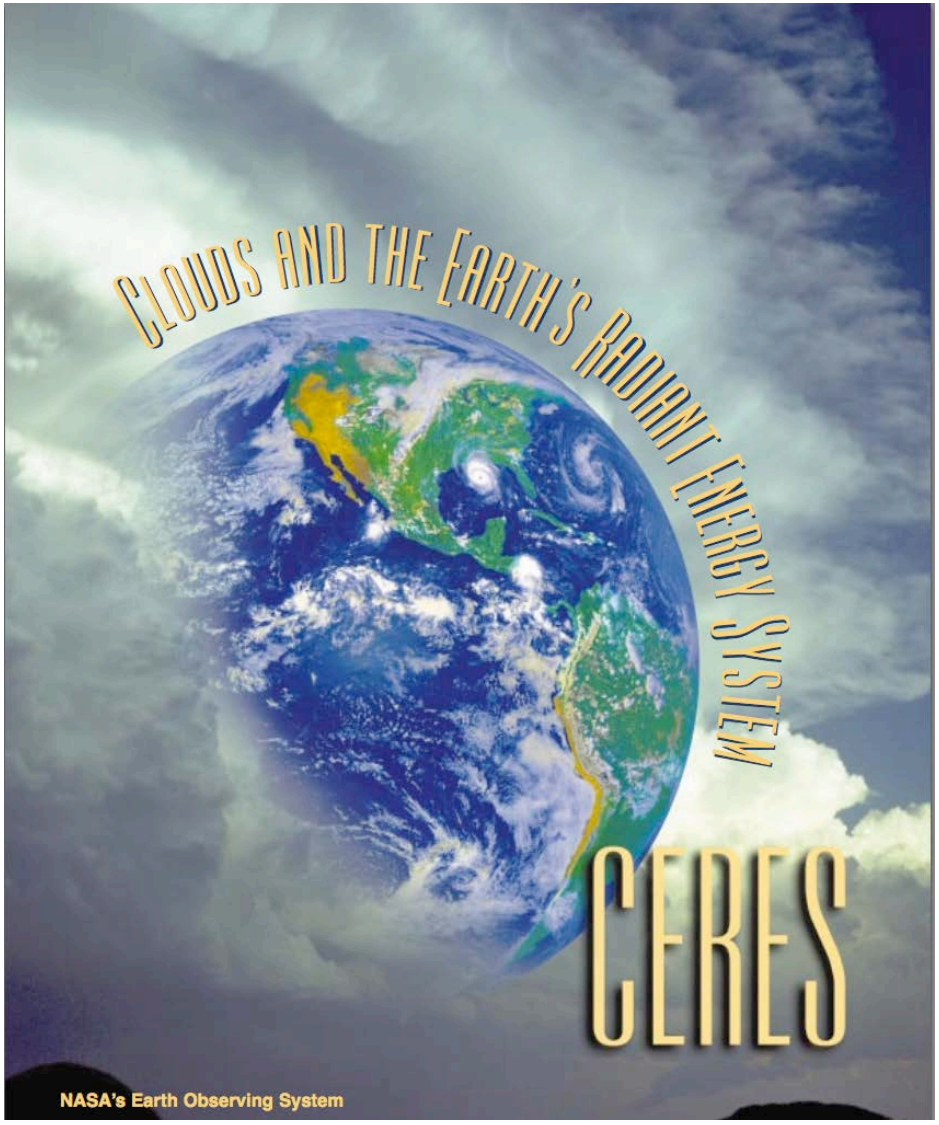
- Denise Cooper -
- Dale Walikainen -
Thomas Grepiotis
Nelson Hillyer
Jeremie Lande
Dianne Snyder
Richard Spivak
Mark Timcoe

Mission Operations

- James Bailey -
- Bill Vogler -
Christopher Brown
John Butler
William Edmonds
Mike Tafazoli
Kelly Teague

Significant increases have been necessary to implement new FM5 and FM6 work

Discussion Topics



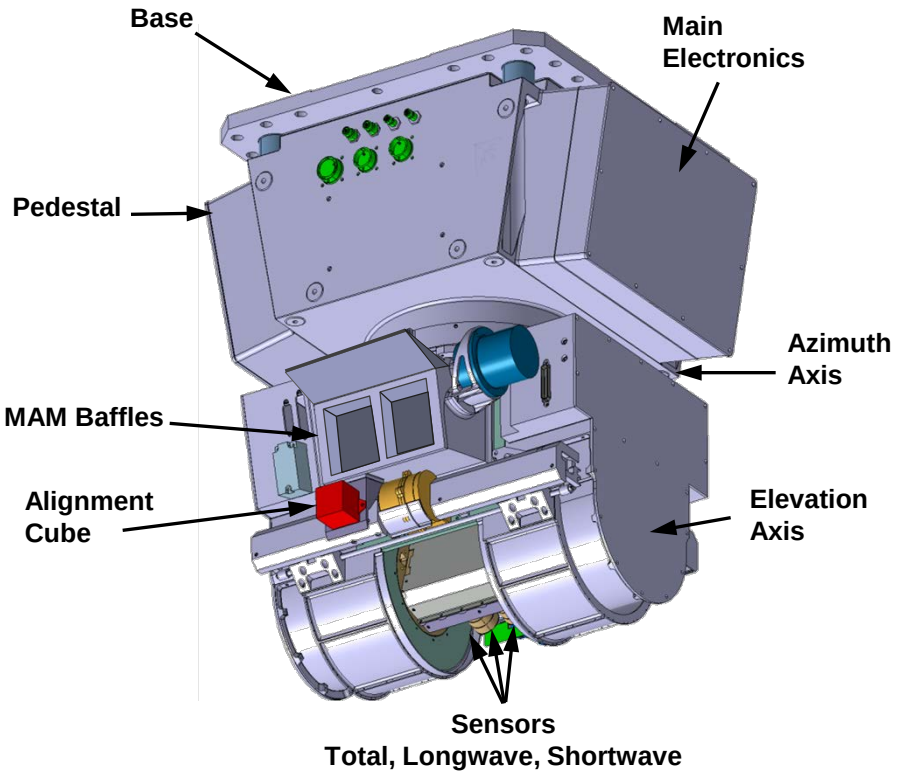
- **Instrument Status**
  - FM-6 on JPSS-1
    - Calibration Status
    - Data Processing Status
  - CERES Follow-on Procurement
- **Summary**

CERES Instrument

Clouds and the Earth's Radiant Energy System

- **Designed, manufactured and tested by TRW, Redondo Beach, CA (currently Northrop Grumman Aerospace Systems)**
- **Contains three sensor assemblies with cassegrain optics and thermistor bolometer detectors**
- **Sensors measure thermal radiation in the near-visible through far-infrared spectral region**
- **Sensor channels are coaligned and mounted on a spindle that rotates about the elevation axis**
- **Hemispherical sampling obtained with an azimuthal axis drive system**

Orbits	705 km altitude, 10:30 a.m. descending node (Terra) or 1:30 p.m. ascending node (PM-1), sun-synchronous, near-polar; 350 km altitude, 35º inclination (TRMM)
Spectral Channels	Solar Reflected Radiation (Shortwave): 0.3 - 5.0 μm Window: 8 - 12 μm Total: 0.3 to > 100 μm
Swath Dimensions	Limb to limb
Angular Sampling	Cross-track scan and 360º azimuth biaxial scan
Spatial Resolution	20 km at nadir (10 km for TRMM)
Mass	45 kg
Duty Cycle	100%
Power	45 W
Data Rate	10 kbps
Size	60 x 60 x 70 cm (deployed)
Design Life	6 years



Enabling Climate Data Record Continuity

CERES Flight Schedule

Spacecraft	Instruments	Launch	Science Initiation	Collected Data (Months)
TRMM	PFM	11/97	1/98	9
Terra	FM1, FM2	12/99	3/00	145 +
Aqua	FM3, FM4	5/02	6/02	117 +
NPP	FM5	10/11	2/12	2
JPSS - 1	*FM6*	*2016 (TBR)*	-	-
JPSS - 2	*ERBS*	*2021 (TBR)*	-	-

44 + Instrument Years of Data

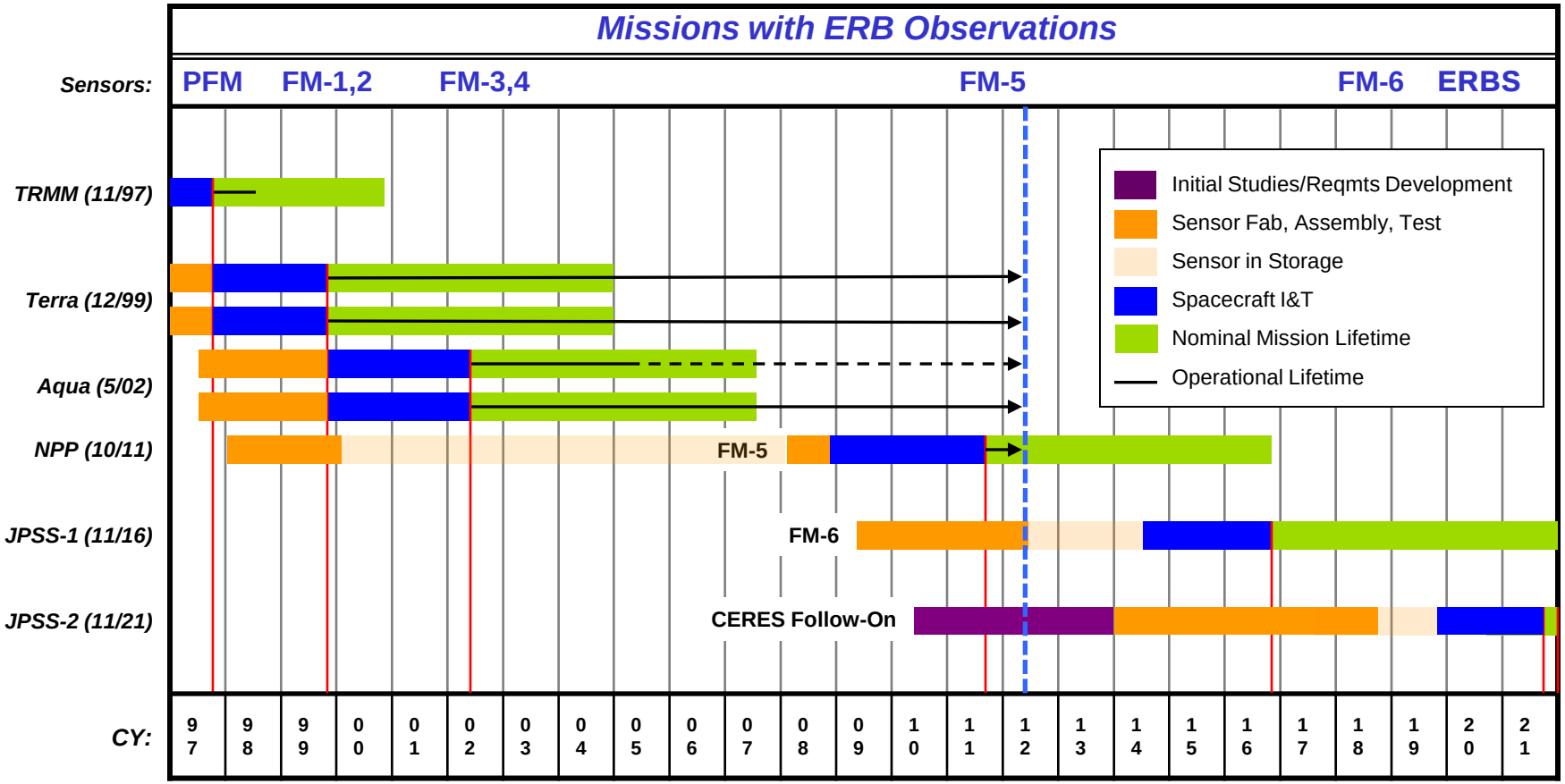
Agency Roles and Responsibilities

Mission	Instruments	Responsible Agency ($$ in budget)		Implementation	
		Hardware	*Science, Data Processing*	*Hardware*	*Science, Data Processing*
EOS	PFM-FM4	NASA	NASA	NASA Procurement	NASA Science Team
NPP	FM5	NASA/***NOAA***	NASA	NASA Procurement	NASA Science Team
JPSS-1	FM6	***NOAA***	***NOAA***	NASA Procurement	***TBR***
JPSS-2	CERES follow-on	***NOAA***	***NOAA***	NASA Procurement	***TBR***

Enabling Climate Data Record Continuity

Clouds and the Earth's Radiant Energy System

CERES Flight Schedule



FM-6 on JPSS-1 Status

CERES FM6 Status & Near-Term Activities

- **Project received ~$5M for FM6 in CY08**
- **Allowed for enhanced study phase only, start 11/08**
- **Long Lead item procurements authorized 3/09**
- **Contract negotiations completed 4/23/09**
- **Key Milestone Dates (Preliminary)**
  - **Authority To Proceed – 5/1/09**
  - **Systems Readiness Review – 9/22/09**
  - **Delta Preliminary Design Review – January 2010**
  - **Delta Critical Design Review – September 28, 2010**
  - **All major subassemblies delivered to NG, currently in sensor I&T**
  - **Radiometric Calibration Facility Upgrades Complete – January 2012**
  - **Pre-Environmental Readiness Review - February 2012**
  - **Ground Calibration Campaign – April/May 2012**
  - ***Delivery to storage – Summer/Fall 2012***
  - ***Launch Date of Nov. 2016 (TBR)***

Radiometric Performance Requirements

CERES is defined as a class 'B' Mission
5-year design Lifetime

Spectral Region	Solar		Terrestrial		Atmospheric Window
Wavelengths	0.3 – 5.0 microns		5 – 200 microns		8-12 microns
Scene Levels	<100 wm^2/sr	>100 wm^2/sr	<100 wm^2/sr	>100 wm^2/sr	All Levels
Accuracy Requirements	0.8 w/m^2-sr	1.0 %	0.8 w/m^2-sr	0.5 %	0.3 w/m^2-sr
SOW Stability Requirements		0.14 %/yr		0.07 %/yr	
FM5 Accuracy Capability		1.7 %		0.7 %	
FM5 Stability Capability		0.32 %/yr		0.12 %/yr	
Climate Stability Goals		< 0.6 w/m^2/dec < 0.03 %/yr		< 0.2 w/m^2/dec < 0.02%/yr	

Current efforts are focused on improving traceability within the reflected solar bands (Short-Wave and Total channels) by enhancing the ground calibration in the short-wave region for FM-6.

CERES Ground Calibration

Radiometric Calibration Facility

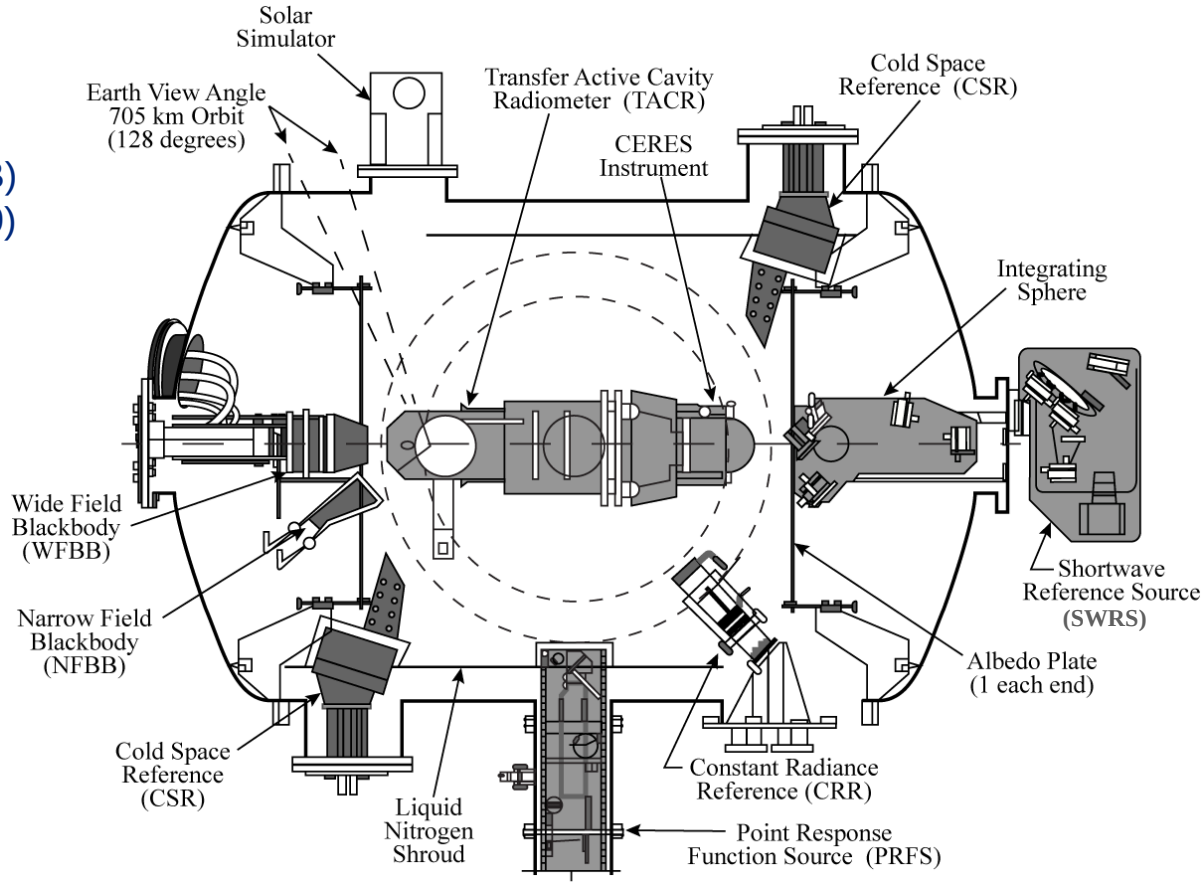
- Heritage ERBE calibration facility
- Revamped for CERES in 90's

Thermal IR Bands

- Narrow Field of View Blackbody (NFBB) is primary standard (emissivity >0.9999)
- 12.5 cm Wide Field of View Blackbody (WFBB)
- Cold Space Reference (CSR) blackbodies

Reflected Solar Bands

- SW reference source (SWRS) with minimum LW variations and spectral characterization capability
  - 13 discrete bands between 420 and 1960 nm
  - 5 cm integrating sphere with associated optics

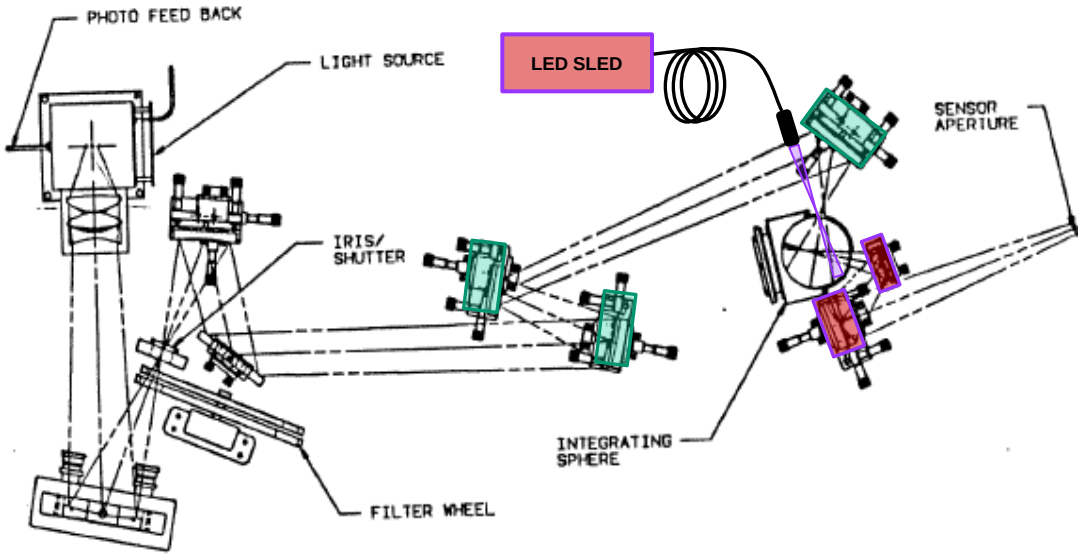


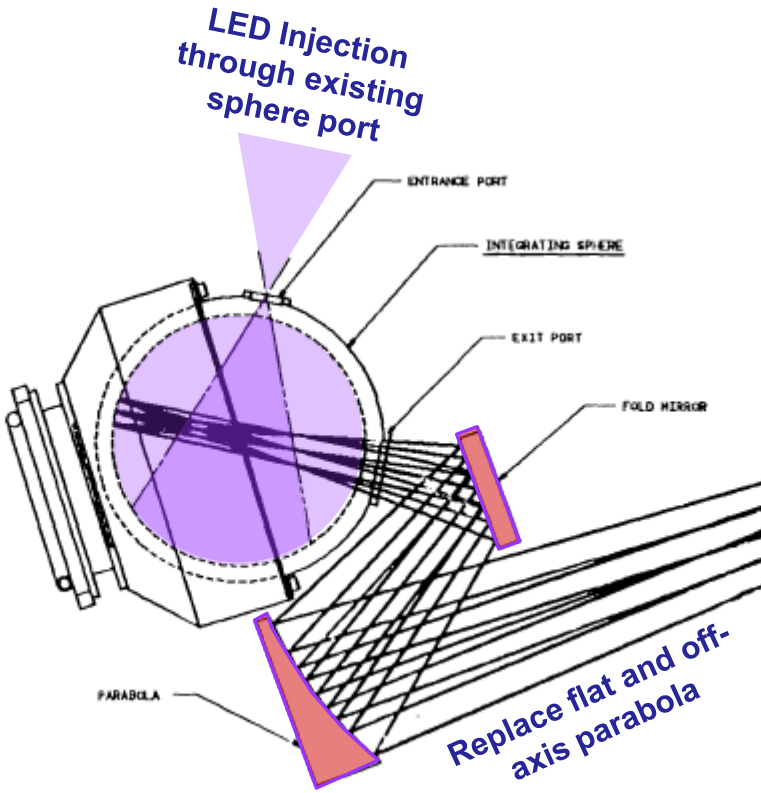
- Cryogenically cooled Transfer Active Cavity Radiometer (TACR)

FM 6 Ground Calibration Improvements

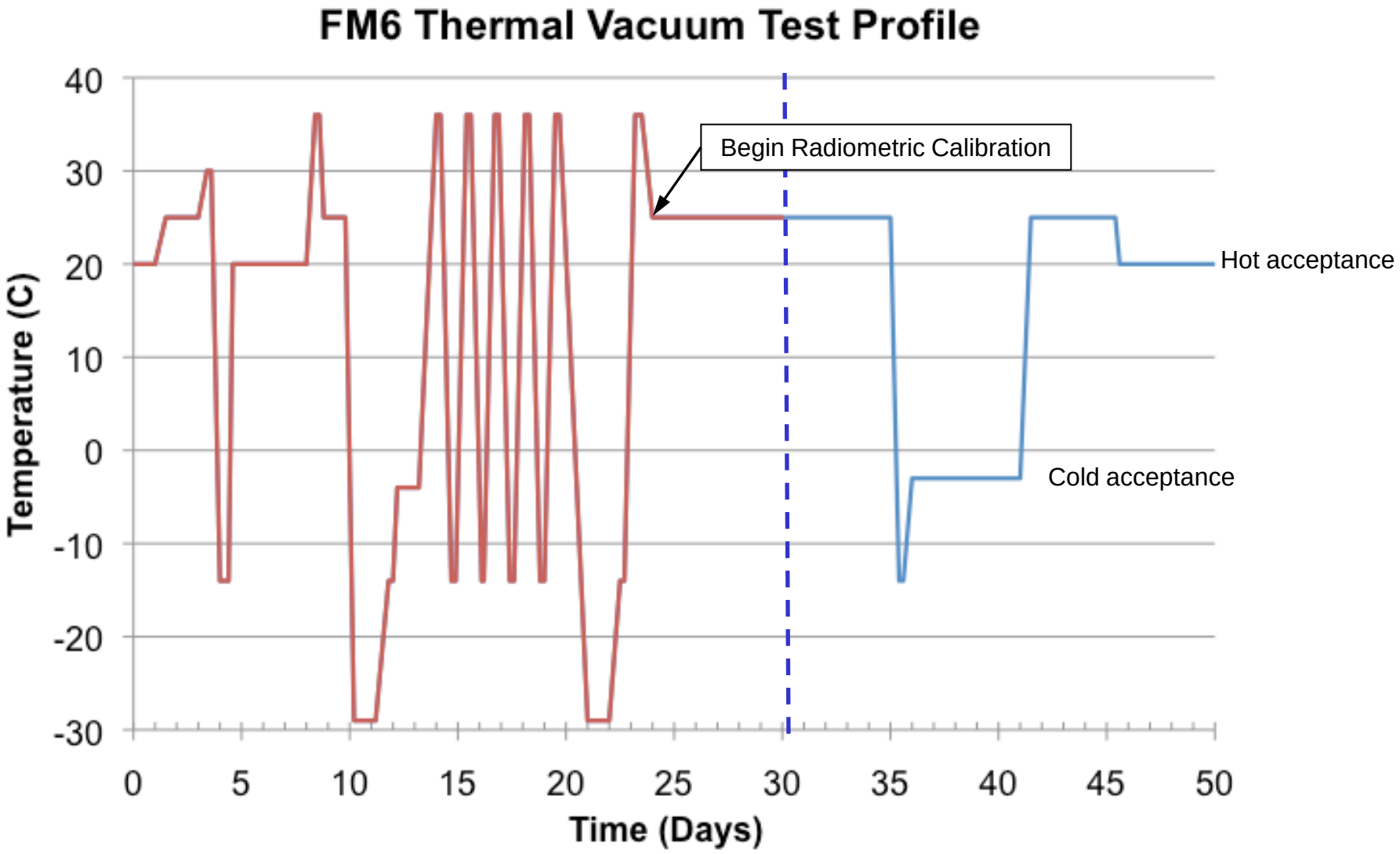
SWRS Improvements

- **Improve SWRS optics**
  - NASA has contracted mirror replacement – enhanced aluminum coatings on mirrors following sphere
  - Option **(Not implemented)** to replace additional mirrors in SWRS optical train to improve throughput
- **Supplement SWRS for increased radiance at the shorter wavelengths**
  - NASA has contracted LED augmentation to existing SWRS
  - Discrete LED sources at 365nm, 385nm and 405nm
  - Option for additional LED coverage up to 970nm
  - Option for future coupling of coherent sources

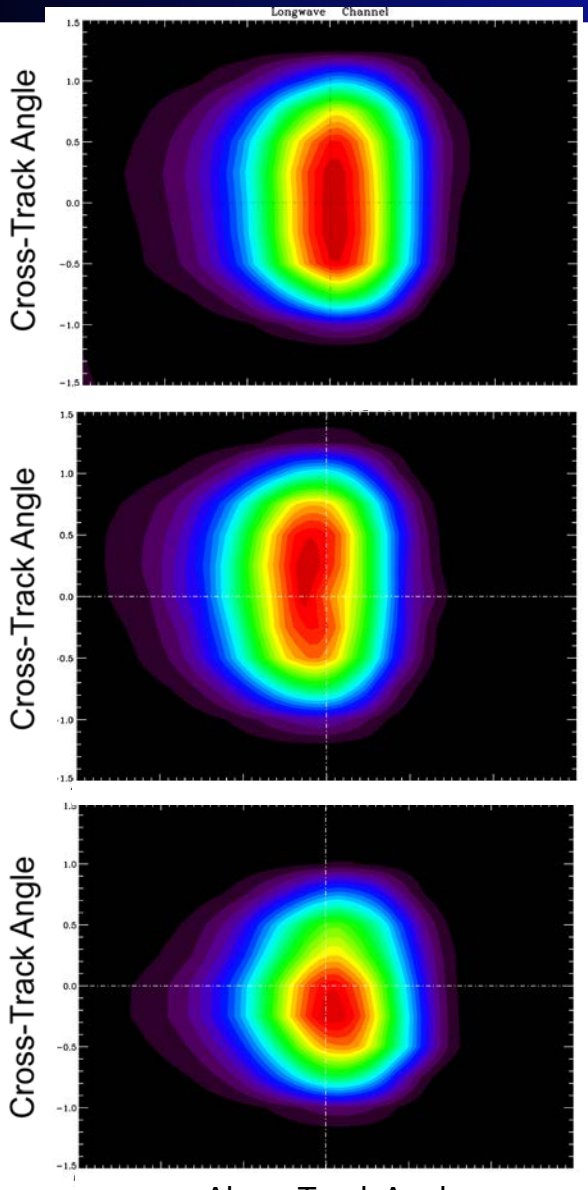




Ground Calibration Timeline



Initial Calibration Results - PSF



Longwave Channel

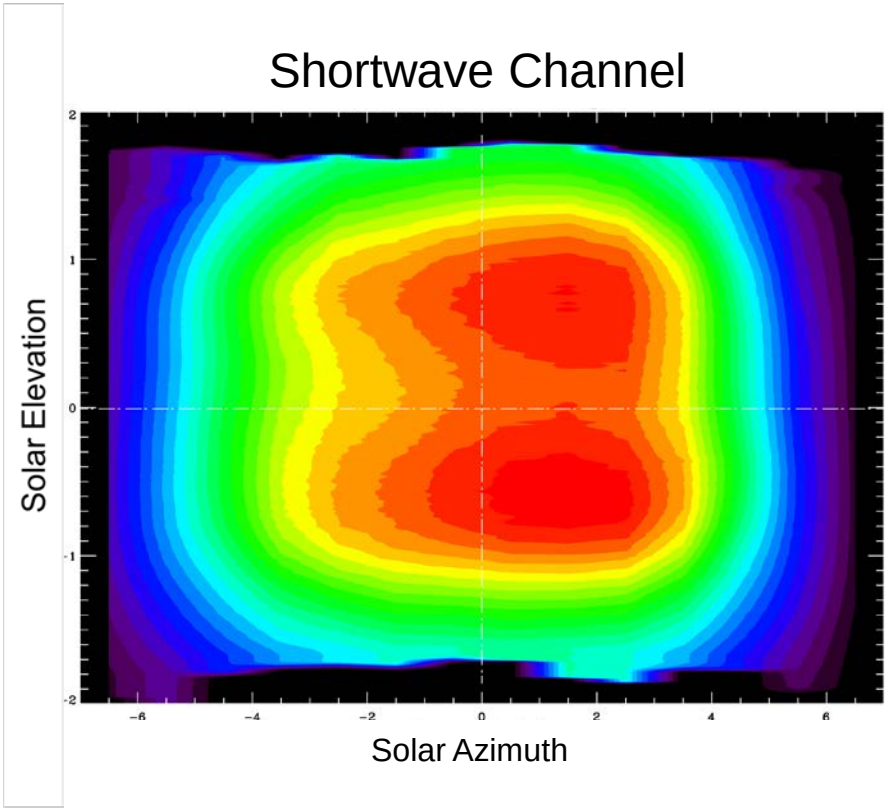
Shortwave Channel

Total Channel

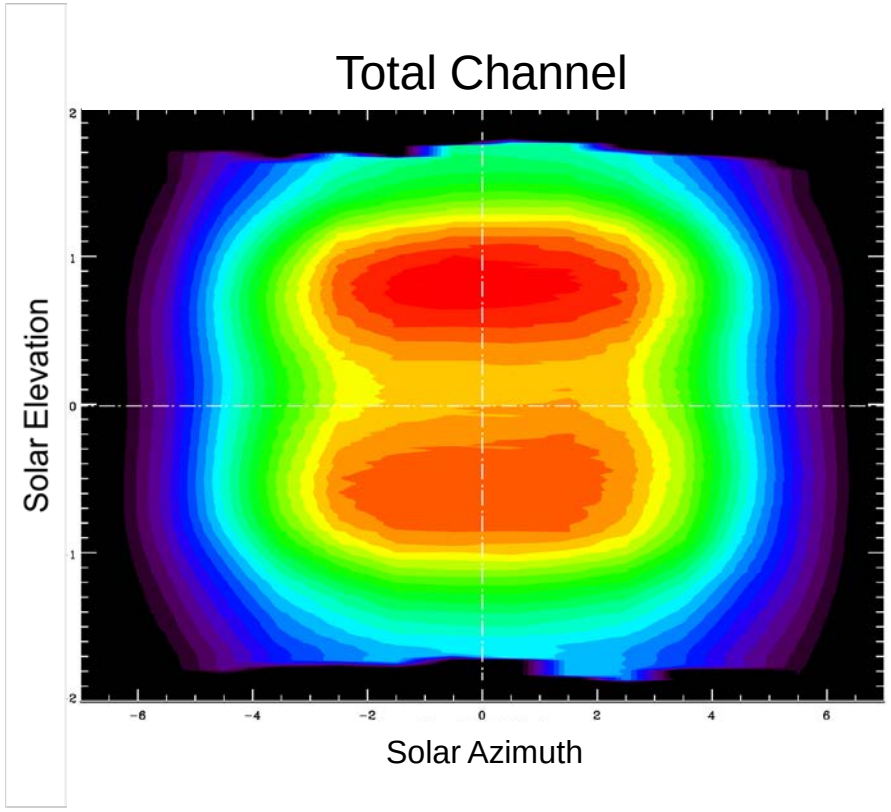
Initial Calibration Results

Solar Diffuser FOV Uniformity

Shortwave Channel



Total Channel

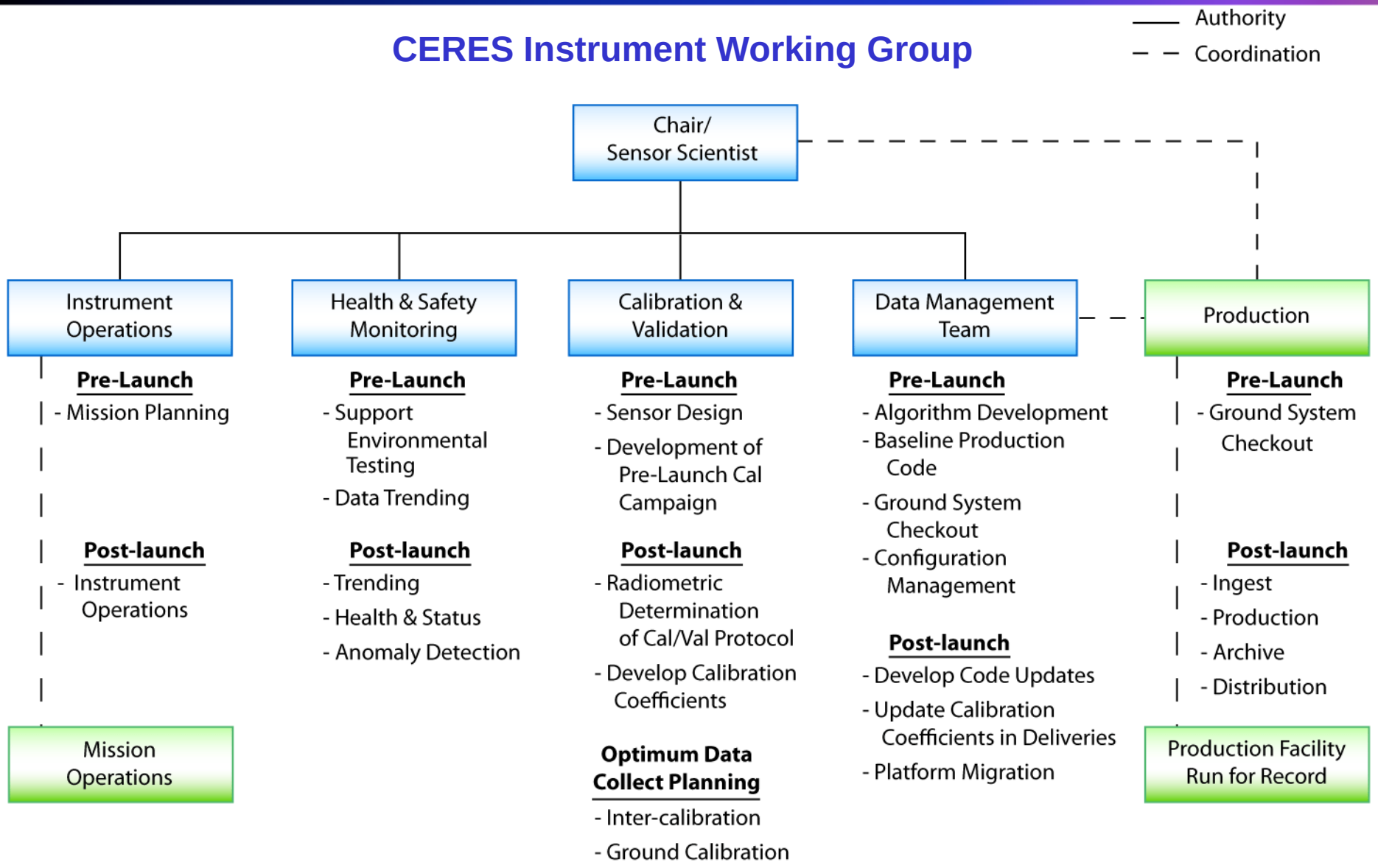


CERES FM6 Science Processing

- **NOAA has responsibility for all ERB Science Data Processing**
  - JPSS Program has responsibility for SDR and EDR Processing
    - 3 ERB Sensor Data Record's (SDR)
      - Total TOA Radiance
      - Longwave TOA Radiance
      - Shortwave TOA Radiance
    - 2 ERB Environmental Data Record's (EDR)
      - Net Solar Flux at TOA
      - Outgoing Longwave Radiation at TOA
  - NOAA Climate Data Records Project has responsibility for CDR Processing
    - Calibrated Sensor Data Record's
      - Preliminary implementation is at LaRC
    - Climate Data Records
      - Implementation TBD

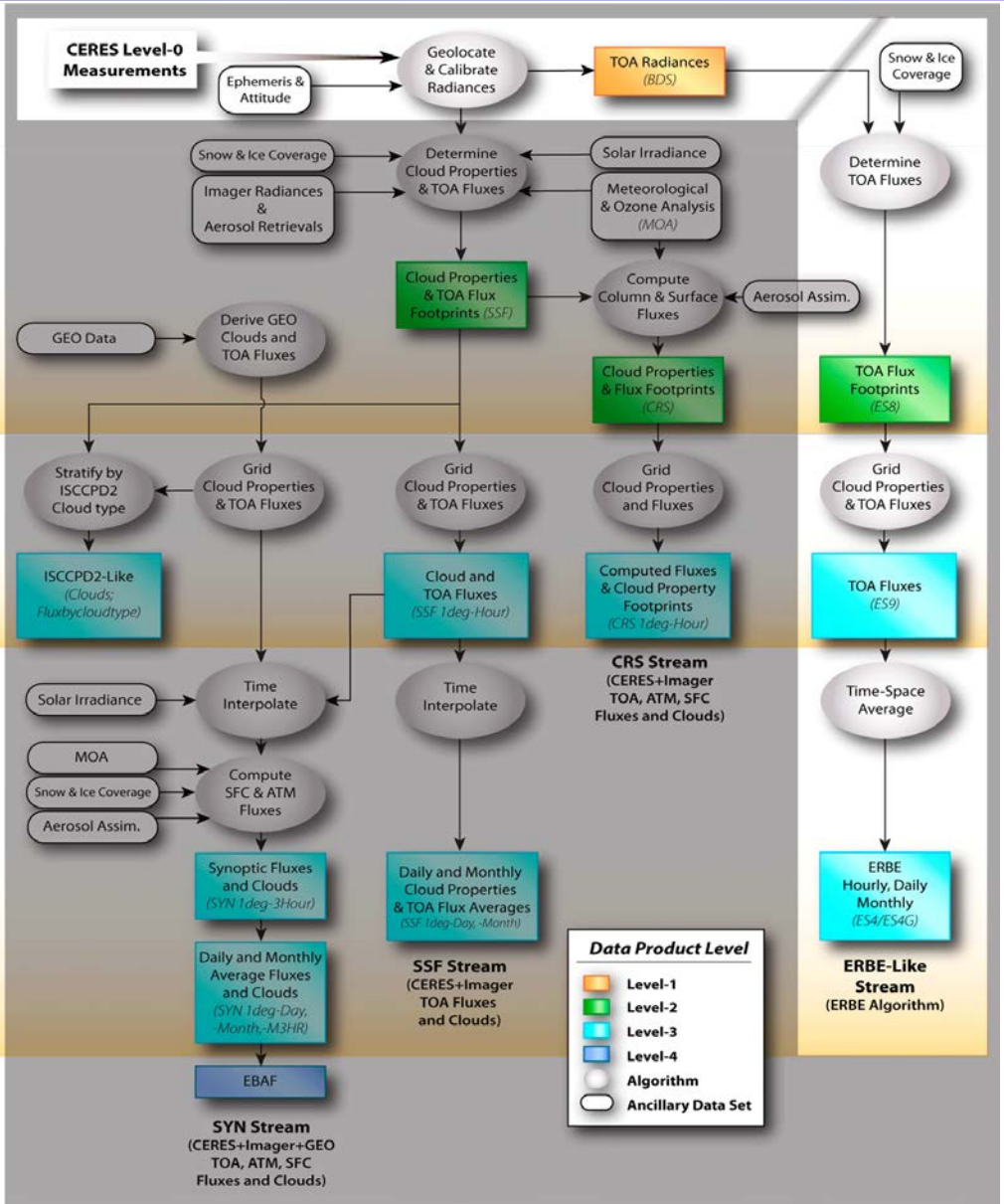
CERES FM6 SDR Implementation

CERES Instrument Working Group

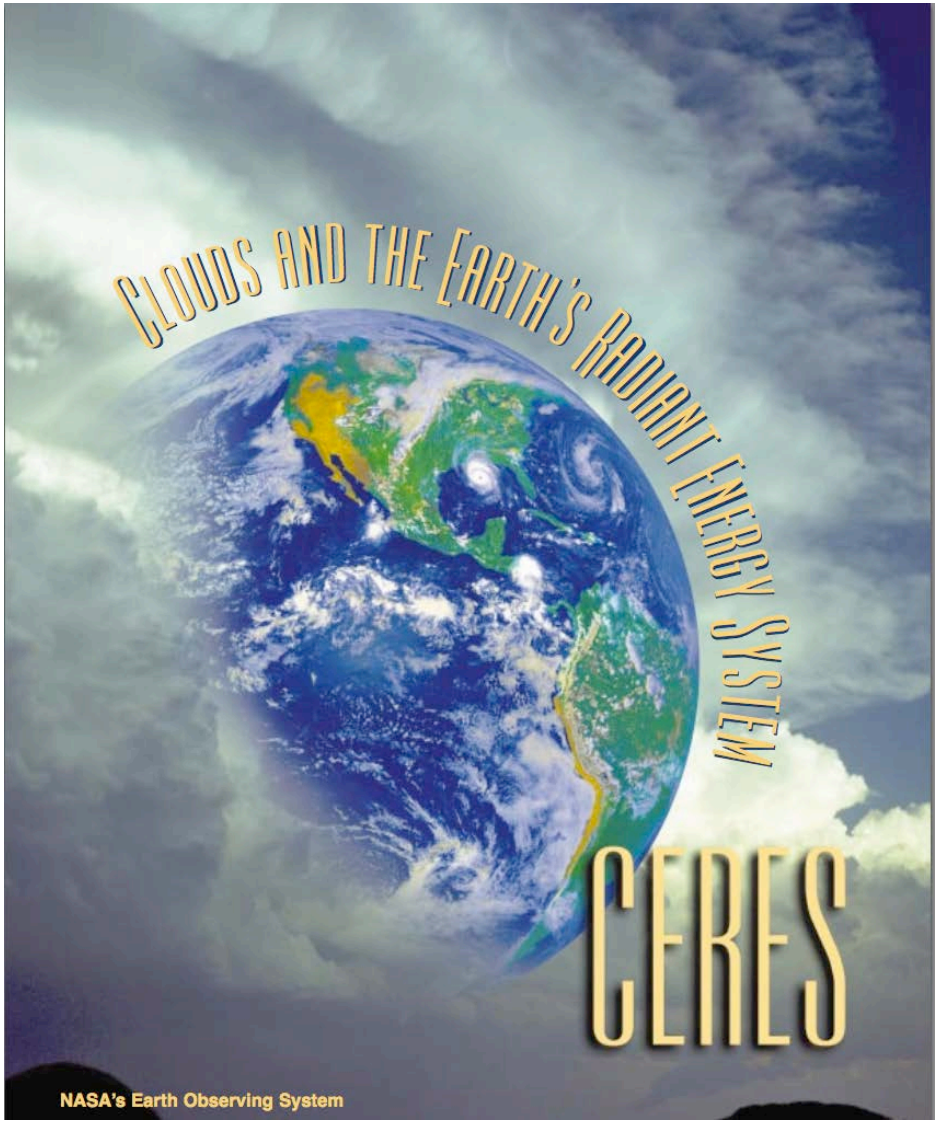


CERES Processing Stream

Clouds and the Earth's Radiant Energy System



Summary



- **FM-6**
  - CERES FM-6 currently completing radiometric characterization
  - Most highly characterized CERES instrument to date.
  - System Acceptance Review currently scheduled for June 2012
  - Launch Currently Scheduled for Nov 2016
- **CERES Follow-on**
  - Sensor Vendor selection anticipated in late 2013