The Evolving Research to Operations Process for NOAA's Satellite Climate Data Records

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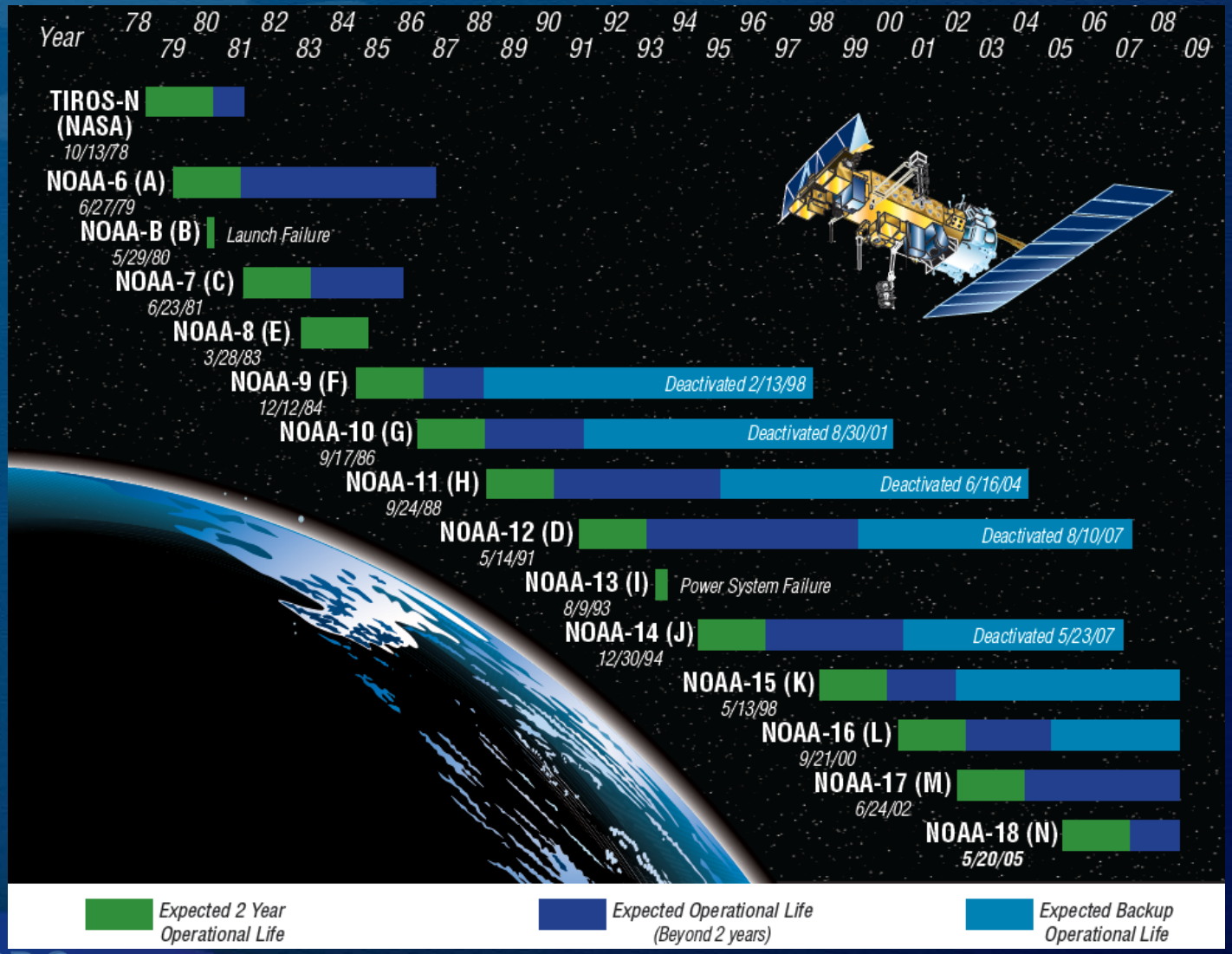
NCDC

NOAA (and Others) Collects Decades of Data using Same or Similar Observing Systems



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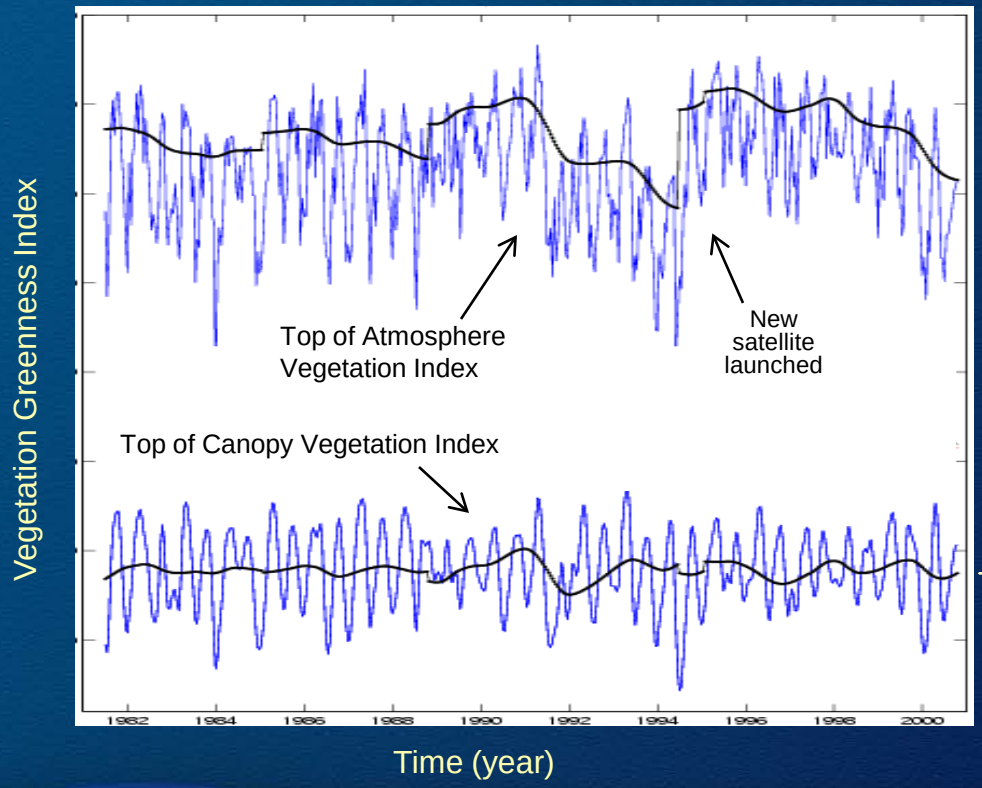
CDRs Require Consistent (Re-)Application of Advanced Algorithms Over Many Satellites and Situations

Uncorrected Data Time Series Contain Both Environmental Information and Satellite-induced Artifacts



← Operational weather and hazard products are produced rapidly to potentially save life and property

Climate Data Records (CDRs) provide long term product consistency through rigorous reprocessing with advanced algorithms, ancillary data and evolved instrument understanding.

Climate Information Records (CIRs) provide specific information about environmental phenomena of particular importance to science and society (*e.g.*, hurricane trends, drought patterns)

NCDC

The CDR Program's Goal

- The National Research Council (NRC, 2004) defines a CDR as a time series of measurements of sufficient length, consistency, and continuity to determine climate variability and change.

- The CDR Program provides proven satellite-derived climate data and information records – including data sets, source codes and documentation – to allow decision-makers, policy-makers and scientists throughout society to make informed decisions and analyses involving future weather and climate.

Program Inputs and Outputs

Input

Output

Performance Metric	2010	2011	2012	2013	2014	2015
CDRs in Operations	3	10	14	18	18	18

Program Inputs and Outputs

Input

1970	1980	1990	2000	2010	2020	2030
POES/GOES/DMSP/EOS (others as appropriate)				NPP	JPSS/GOES-R/JASON-x/DWSS (others as appropriate)	

Competitively-selected Community Experts

Output

Performance Metric	2010	2011	2012	2013	2014	2015
CDRs in Operations	3	10	14	18	18	18

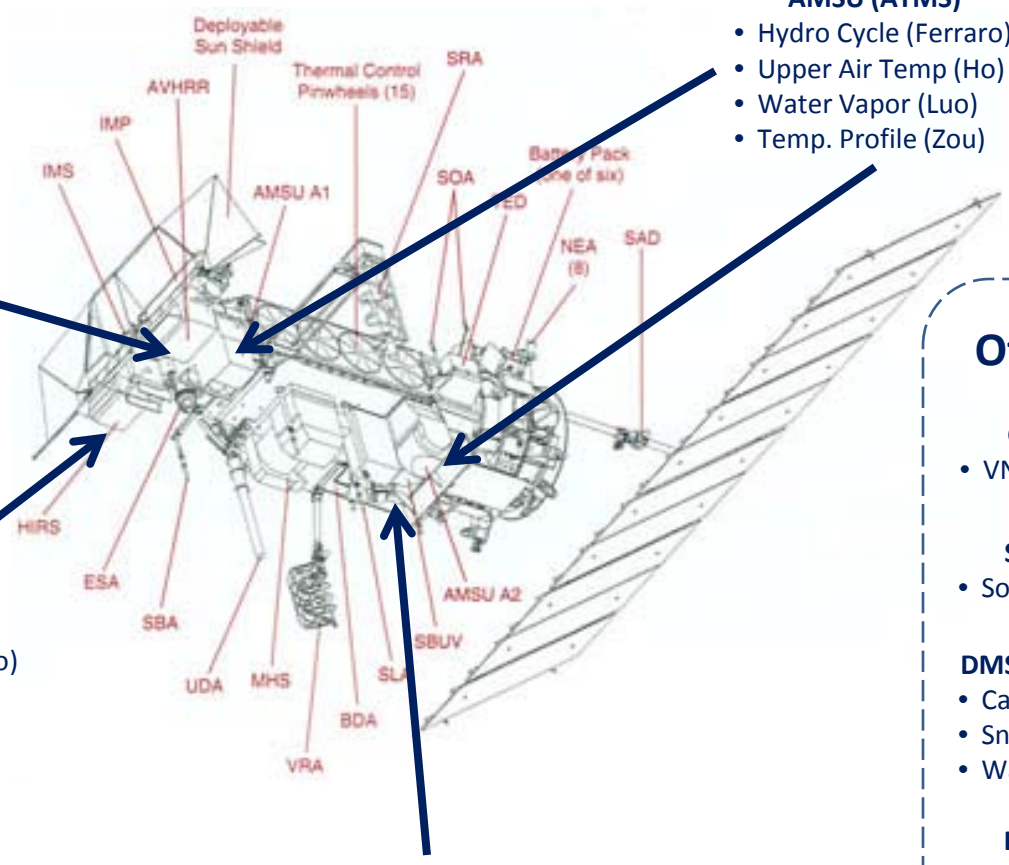
14 CDR Development Awards in Past 2 Years

(+7 additional efforts continued from prior awards)

NOAA POES Satellite Platform

AVHRR (VIIRS)
- Cloud Properties (Kato)
- Snow/Ice (Key)
- VNIR Cal./Clouds (Minnis)
- Thermal Calibration (Mittaz)
- Land/Carbon (Vermote)
- Ocean Fluxes (Clayson)

AMSU (ATMS)
- Hydro Cycle (Ferraro)
- Upper Air Temp (Ho)
- Water Vapor (Luo)
- Temp. Profile (Zou)



HIRS (CrIS)
- FCDR/Intersensor calibration (Cao)
- Water Vapor (Luo)
- Cloud Properties (Menzel)

SBUV (OMPS)
- Ozone (Flynn)

Other Satellites

GOES: Imager (ABI)
- VNIR Cal./Clouds (Minnis)

SORCE, Glory (TSIS)
- Solar Irrad. (Pilewskie)

DMSP: SSM/I, SSMIS (MIS)
- Calibration (Kummerow)
- Snow/Ice (Key)
- Water Vapor (Luo)

ERBS: ERBE (CERES)
- Radiation Budget (Kato)

GPS RO (Various)
- Temp. Profiles (Ho)

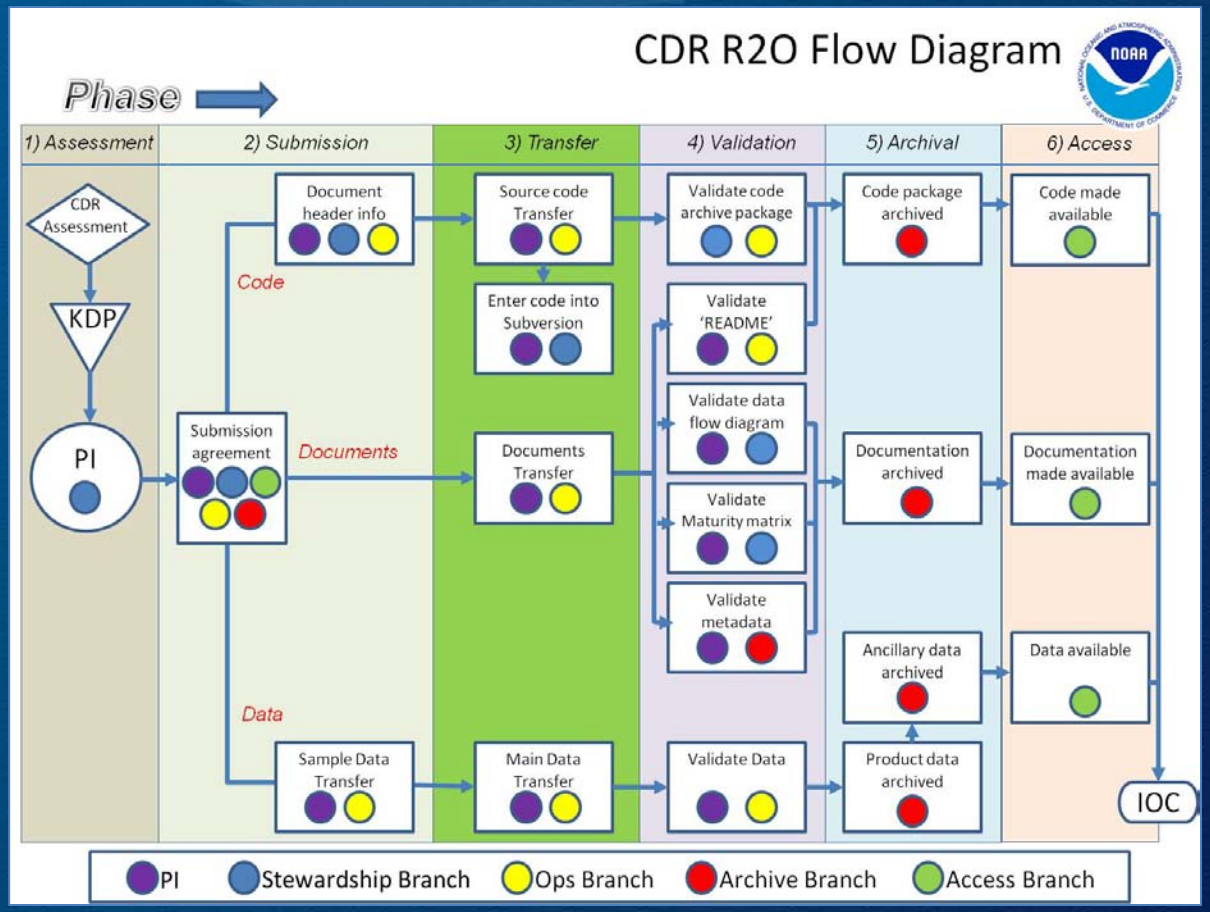
Arrows identify key climate sensor on NOAA polar platform (POES)

Two Phase "Operationalization" of NOAA CDRs

- Initial Operational Capability (IOC) is a CDR development state achieved when a CDR -- including the data set, source code and documentation -- is reproducible and is archived, maintained, and made publicly available at NOAA's National Climatic Data Center. NOAA commits to extending the data set in time as possible.
  - Addresses needs of many operational decision-support systems and users
  - NCDC complies with established standards of OAIS, NARA and NOAA
  - Code condition may vary; Generation responsibility may vary

- Full Operational Capability (FOC) is a CDR development state achieved when a CDR meets IOC requirements *and* is being systematically and routinely generated by NOAA using codes and systems that conform to the CDR Program's IT security, coding and documentation standards.
  - Meets government goal of acquiring capabilities to provide uninterrupted and indefinite data provision

Research-to-Operations Process for IOC



Procedures to achieve Initial Operational Capability

Code

Enter source code into Subversion
Document Header information
Create README (Cookbook) – Detailed run instructions
Archive source code and README package
Make source code and README package available (web)

Documents

Flow Chart of process
Maturity Matrix - lvl 3 avg
Source Code headers (robodoc preferred)
Algorithm Theoretical Basis Document (ATBD)
Archive Document Package
FGDC Metadata for product
Make docs available (web)

Data Set

Submission agreement in place
Archive available Input/Ancillary Data
Product Archived
Product available (THREDDS or HAS)

CDRs At Initial Operational Capability

FY2010 CDRs Transitioned to IOC

1. **Polar imager reflectance** (AVHRR series) -- Univ. Wisconsin / STAR
2. **Geostationary imager thermal radiance** (International series) -- NCDC
3. **Polar thermal sounder radiance** (Water vapor band of HIRS series) – NCDC

CDRs Moving to Initial Operational Capability

FY2011 CDRs Transitioning to IOC*

1. **Sea Ice Extent** (SSM/I, SSMIS) – Univ. Colorado/CIRES/NSIDC
2. **Atmospheric Temperature Profile** ([A]MSU) – Univ. of Alabama
3. **Microwave Sounder Calibrated Bright. Temp.** ([A]MSU) – NCAR
4. **Microwave Imager Calibrated Bright. Temp.** (SSM/I) – Remote Sensing Sys.
5. **Aerosol Optical Depth** (AVHRR) – NCDC (Official GACP Product)
6. **Outgoing Longwave Radiation** (HIRS) – Univ. of Maryland
7. **Sea Surface Temperature** (AVHRR) – Univ. of Miami & NODC (Pathfinder)

Risk Reduction: ISCCP Cloud Climatology (AVHRR, GOES) – CCNY

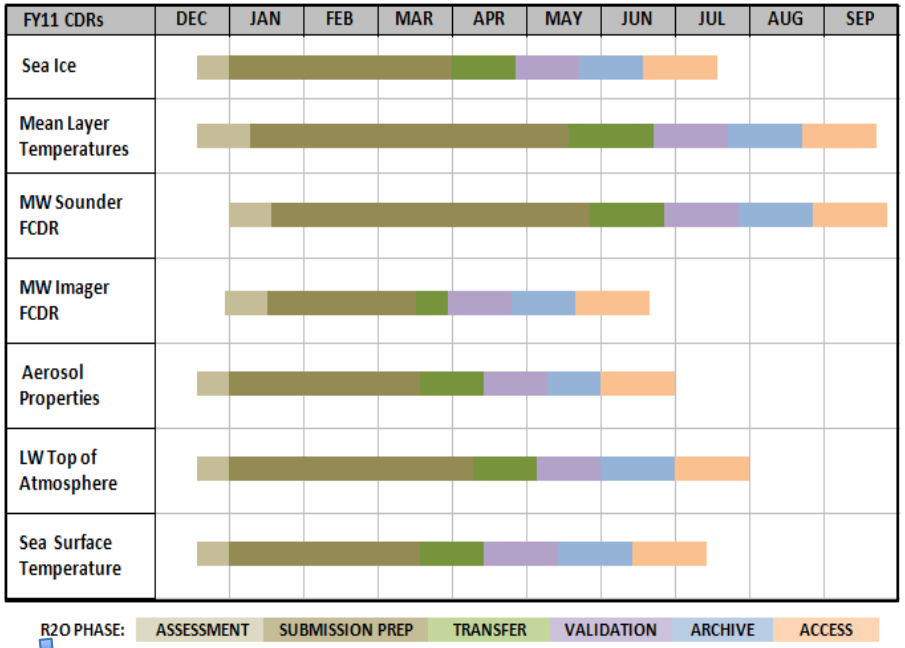
* Assumes Congress approves President's FY2011 budget for CDR Program

CDR Program Office

FY11 Climate Data Records Transitioning to IOC

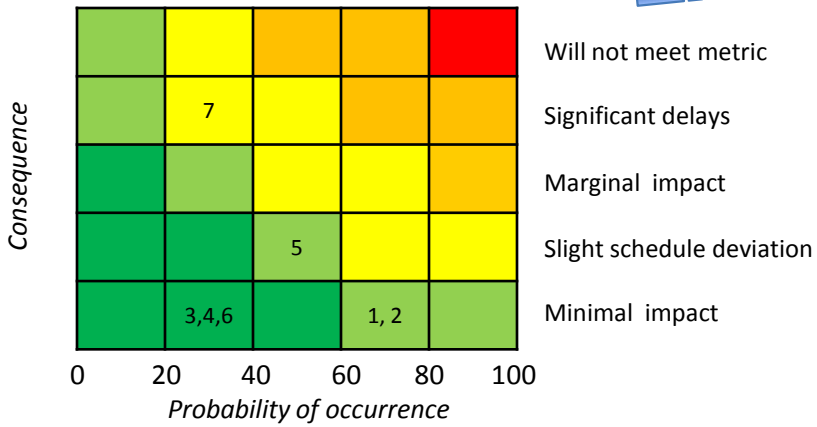
Weekly Report – Jan 14, 2011

1. **Sea Ice**
   - Initial assessment complete – NSIDC coordination needed
2. **Mean Layer Temperatures**
   - Initial assessment complete – telecon with PI needed
3. **Microwave Sounder FCDR**
   - Initial assessment complete – on schedule
4. **Microwave Imager FCDR**
   - Initial assessment complete – data and docs transferred
5. **Aerosol Properties**
   - Initial assessment complete –on schedule
6. **Longwave Radiation - Top of Atmosphere (TOA)**
   - Initial assessment complete – on schedule
7. **Sea Surface Temperature**
   - Initial assessment complete – NODC coordination needed



Example

Risk Matrix



Risk and Mitigation

Sea Surface Temp - Complete process from L1b-to-NetCDF still has to be validated, processing path is 2-step at present: U of Miami then NODC. Extra resources put to ensuring PI has timely access to raw data.

= On-track = Potential management action required = Management attention required

Research-to-Operations Process for FOC

Party	Principal Investigator	Advisory Group	Development Team	System Testing	Program Mgmt.	Operations Team	Community
Action	Algorithm & Product Development	Value & Viability Assessment	System Development & Integration	System Test System Acceptance Test	Operational Readiness Review	Production Operations (DQM)	Product & Algorithm Validation / Assessment
Output	Product Package / Research Grade Code	Transition to Operations Decision	Operational System Package / Integrated, Operational Grade	Accepted Operational System Package	Authorized Operational System Package	Data Products	Issues & Recommendations

CDR Product Evolution Path

Supporting Infrastructure							
	Science & Collaboration Environment		Systems Development & Integration Environment	Quality Control & Testing Environment		Production Operations Environment	

Common Architecture / Development Framework

CLIMATE DATA RECORDS PROGRAM

News

91st AMS Annual Meeting

Welcome to NCDC's CDR Program

NOAA's National Climatic Data Center (NCDC) recently initiated a satellite Climate Data Records (CDR) program to continuously provide objective climate information derived from weather satellite data that NOAA has collected for more than 30 years. These data comprise the longest record of global satellite mapping measurements in the world, and are complemented by data from other sources including NASA and Department of Defense satellites as well as foreign satellites.

The mission of NOAA's Climate Data Record Program is to develop and implement a robust, sustainable, and scientifically defensible approach to producing and preserving climate records from satellite data.

WHAT ARE CDRs?

The National Research Council (NRC) defines a CDR as a time series of measurements of sufficient length, consistency, and continuity to determine climate variability and change. (National Research Council, 2004).

For the first time, NOAA is applying modern data analysis methods, which have advanced significantly in the last decade, to these historical global satellite data. This process will unravel the underlying climate trend and variability information and return new economic and scientific value from the records. In parallel, NCDC will maintain and extend these Climate Data Records by applying the same methods to present-day and future satellite measurements.

WHY ARE CDRs IMPORTANT?

The results will provide trustworthy information on how, where and to what extent

Serving the Public

- NOAA Climate Services
- United States Global Change

CLIMATE DATA RECORDS PROGRAM

- CDR Program 2010
- CDR Program 2009
- SDS Program 2008
- SDS Program 2007
- ARC
- Serving the Public
- Data
- Development Guidelines
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Developmental CDRs

NCDC Developmental CDRs use applicable data from current and heritage satellites to generate Operational CDRs. These CDRs are being developed through our peer reviewed, competitive grants program.

Climate Data Records (CDR) Program, 2010 Selections

Top

PI Name	Project Title and Abstract	Serving Public	Progress Reports Year 1	Year 2	Year 3	Links
Clayson	The Development of a 20-year Database of Ocean Surface and Near-Surface Properties Suitable for Climate Analyses					• Product Description • 2010 Program Review
Ferraro	The Development of AMSU FCDR's and TCDR's for Hydrological Applications					• Product Description • 2010 Program Review
Ho	Construction of Consistent Microwave Sensor Temperature Records and Tropopause Height Climatology using MSU/AMSU Measurements, GPS RO Data and Radiosonde Observations					• Product Description • 2010 Program Review
Kato	Development of a Radiation Climate Data Record Combining ERBE and AVHRR					• Product Description • 2010 Program Review
Luo	Creating UTH-Related FCDRs from IR and Microwave Sensors Cross-Calibrated by In Situ Measurements from Commercial Aircraft					• Product Description • 2010 Program Review
Menzel	Re-Calibrating HIRS and Evaluating Associated Impact on Cloud and Moisture Properties					• Product Description • 2010 Program Review
Minnis	Calibration of Historical and Future AVHRR and GOES Visible and Near-Infrared Sensors and the Development of a Consistent Long-Term Cloud and Clear-Sky Radiation Property Dataset					• Product Description • 2010 Program Review

Climate Data Records (CDR) Program, 2009 Selections

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Serving the Public

NOAA's National Climatic Data Center (NCDC) recently initiated a satellite Climate Data Record program to continuously provide objective climate information based on weather satellite data that NOAA has collected over the past 30 years. This data is the longest global satellite measurement record in the world and represents billions of dollars of investment.

So what is the benefit to the public? The results will provide trustworthy, observation-based information on how, where and to what extent the land, oceans, atmosphere and ice sheets are changing. We are actively engaging numerous public sectors such as agriculture, health, energy, security, water supplier, coastal community and others to address societal needs by providing information to make better decisions.

NOAA Climate Services Five Societal Challenges

The above link provides the NOAA Climate Services Draft Vision and Strategic Framework document that describes how NOAA proposes to respond to society's growing need for climate services. Specifically, it addresses the five societal challenges that are illustrated below.

Water Resources

Coastal Resilience

Marine Ecosystem

Climate Extremes

Informing Policy

NOAA Climate Services: Climate and You

The above link is NOAA's Climate Services portal. Climate information is essential for business, community and natural resource planning. Our resources focus on the needs of society. This portal gives a detailed description of the seven sector's (see icons below) key issues.

Agriculture

Ecosystems

Energy

Health

Society

Transportation

Water

United States Global Change Research Program (USGCRP): Sectoral Climate Information (Federal Interagency Partnerships)

The above link is the U.S. Global Change Research Program (USGCRP) that coordinates and integrates federal research on changes in the global environment and their implications for society. This web site's Sectorial Climate Information page describes the seven sectors and their critical issues.

Agriculture

Ecosystems

Energy Supply and Use

Human Health

Society

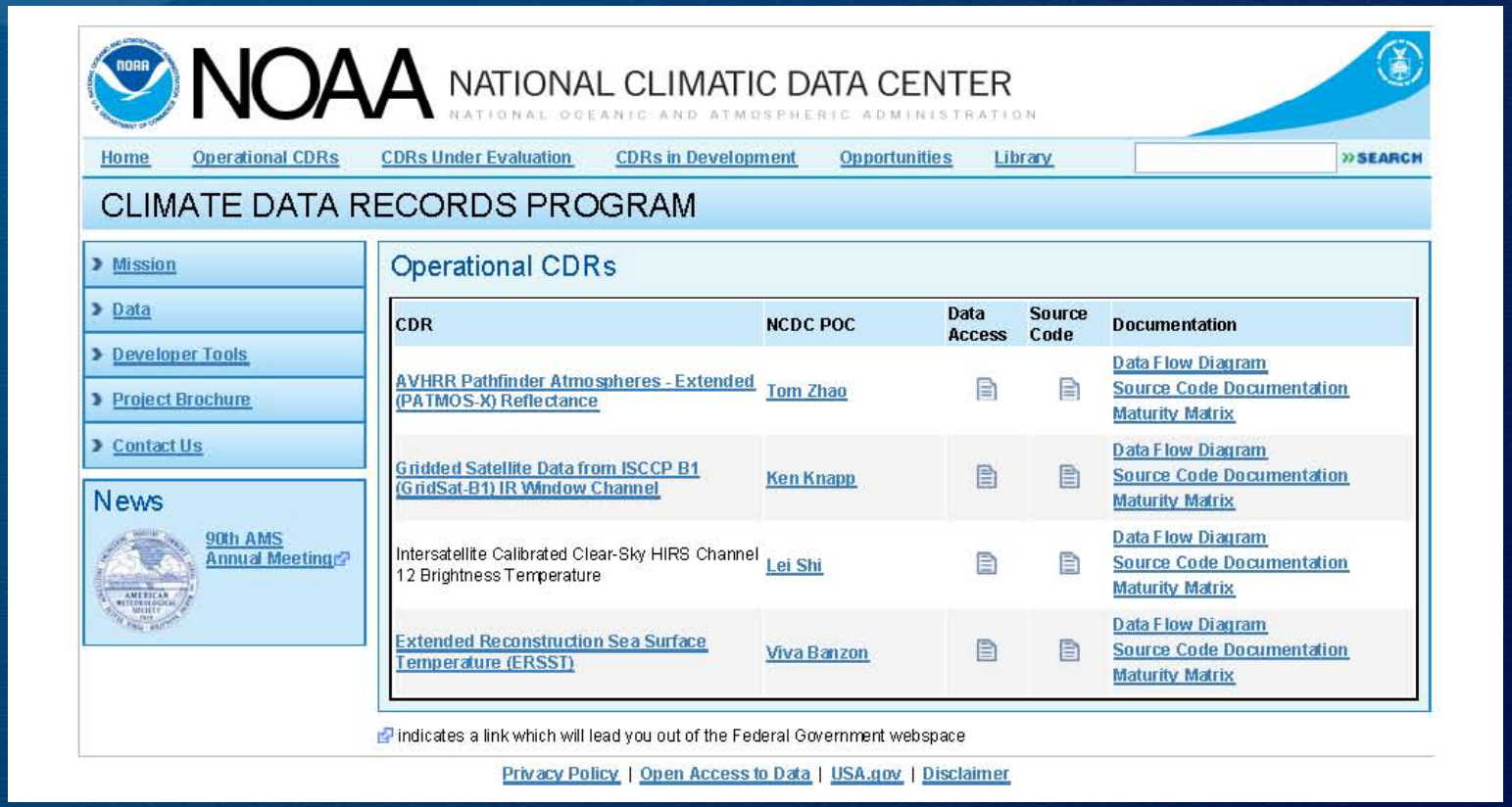
Transportation

Water Resources

The Global Earth Observation System of Systems (GEOSS) (International Partnerships)

The above link is the Global Earth Observation System of Systems (GEOSS) that focuses on providing decision-support tools to

Public Access to Operational CDRs



NOAA NATIONAL CLIMATIC DATA CENTER
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Home | Operational CDRs | CDRs Under Evaluation | CDRs in Development | Opportunities | Library | SEARCH

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Operational CDRs

CDR	NCDC POC	Data Access	Source Code	Documentation
AVHRR Pathfinder Atmospheres - Extended (PATMOS-X) Reflectance	Tom Zhao			Data Flow Diagram Source Code Documentation Maturity Matrix
Gridded Satellite Data from ISCCP B1 (GridSat-B1) IR Window Channel	Ken Knapp			Data Flow Diagram Source Code Documentation Maturity Matrix
Intersatellite Calibrated Clear-Sky HIRS Channel 12 Brightness Temperature	Lei Shi			Data Flow Diagram Source Code Documentation Maturity Matrix
Extended Reconstruction Sea Surface Temperature (ERSST)	Viva Banzon			Data Flow Diagram Source Code Documentation Maturity Matrix

indicates a link which will lead you out of the Federal Government webspace

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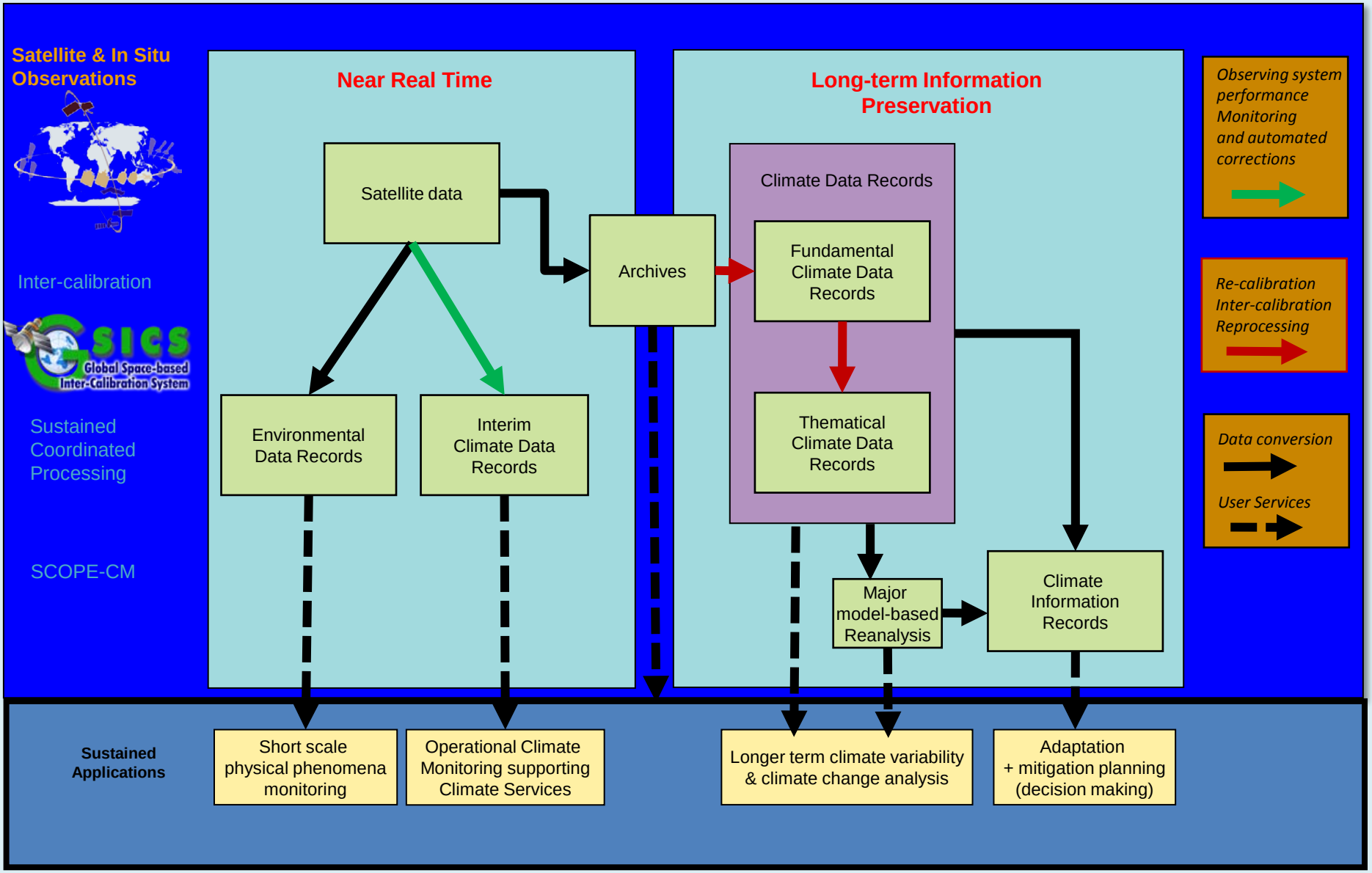
http://www.ncdc.noaa.gov/cdr

Summary

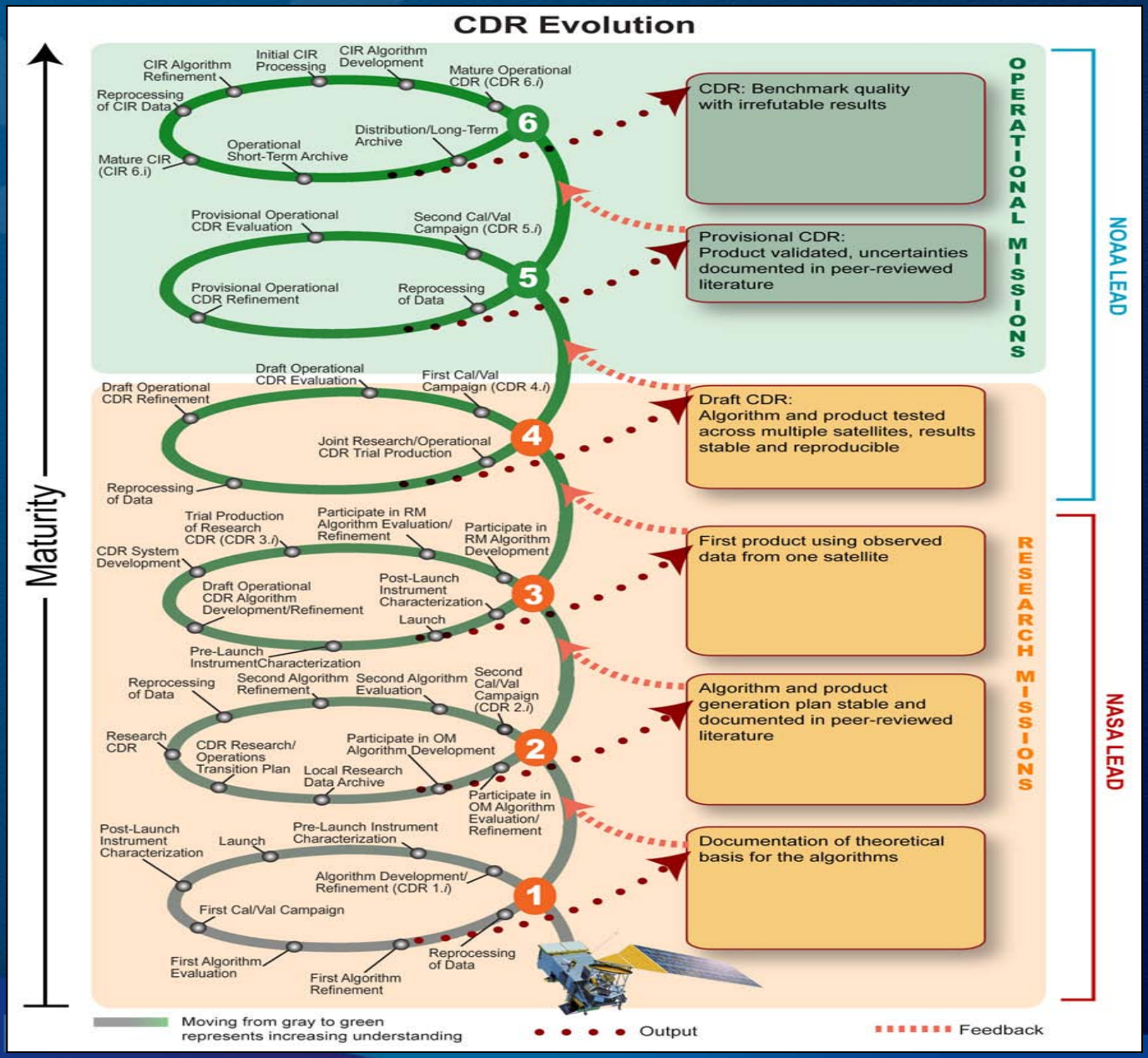
- A two-stage research-to-operations process has been adopted (IOC, FOC)
- 3 CDRs achieved IOC in Year 2010. 7 more transitioning in Year 2011. All developed by competitively-selected community experts.
- CDR data sets support the Societal Challenges and Societal Benefit Areas identified by NOAA Climate Services and USGCRP
- CDR website provides program transparency and access to data, source codes, and progress information

Thanks!

Sustained Climate Information Flow



CDR Development Starts With Mature Algorithms



Maturity Matrix Identifies Milestones and Research-to-Operations Transition Points

v. June 2010

Level	Sensor Use	Code Stability	Metadata & QA	Documentation	Validation	Public Release	Science & Applications	Milestone Reviews
1	Research Mission	Significant changes likely	Incomplete	Draft ATBD	Minimal	Limited data availability to develop familiarity	Little or none	
2	Research Mission	Some changes expected	Research grade (extensive)	ATBD Version 1+	Uncertainty estimated for select locations/times	Data available but of unknown accuracy; caveats required for use.	Limited or ongoing	ATBD Review
3	Research Missions	Minimal changes expected	Research grade (extensive); Meets international standards	Public ATBD; Peer-reviewed algorithm and product descriptions	Uncertainty estimated over widely distribute times/location by multiple investigators; Differences understood.	Data available but of unknown accuracy; caveats required for use.	Provisionally used in applications and assessments demonstrating positive value.	NOAA Operations Review
4	Operational Mission	Minimal changes expected	Stable, Allows provenance tracking and reproducibility; Meets international standards	Public ATBD; Draft Operational Algorithm Description (OAD); Peer-reviewed algorithm and product descriptions	Uncertainty estimated over widely distribute times/location by multiple investigators; Differences understood.	Source code released; Data available but of unknown accuracy; caveats required for use.	Provisionally used in applications and assessments demonstrating positive value.	
5	All relevant research and operational missions; unified and coherent record demonstrated across different sensors	Stable and reproducible	Stable, Allows provenance tracking and reproducibility; Meeting international standards	Public ATBD, Operational Algorithm Description (OAD) and Validation Plan; Peer-reviewed algorithm, product and validation articles	Consistent uncertainties estimated over most environmental conditions by multiple investigators	Source code portable and released; Multi-mission record is publicly available with associated uncertainty estimate	Used in various published applications and assessments by different investigators	CDR Certification Review
6	All relevant research and operational missions; unified and coherent record over complete series; record is considered scientifically irrefutable following extensive scrutiny	Stable and reproducible; homogeneous and published error budget	Stable, Allows provenance tracking and reproducibility; Meeting international standards	Product, algorithm, validation, processing and metadata described in peer-reviewed literature	Observation strategy designed to reveal systematic errors through independent cross-checks, open inspection, and continuous interrogation	Source code portable and released; Multi-mission record is publicly available from Long-Term archive	Used in various published applications and assessments by different investigators	

CDR Developers Organizing Into Thematic Teams For Production Efficiency & Coherent Products

Thematic CDR Teams

- Atmospheric Profiles
- Ocean
- Solar Irradiance
- Clouds & Aerosols
- Land
- Radiation Budget
- Ozone & Trace Gases
- Cryosphere
- Precipitation

Fundamental CDR Teams

- Sensor (Level 1) Calibration Teams