NOAA Climate Data Record (CDR) Program and Products:
Briefing to the NOAA Climate Reanalysis Task Force
(seeking opportunity and collaboration)

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28 January 2015

Outline

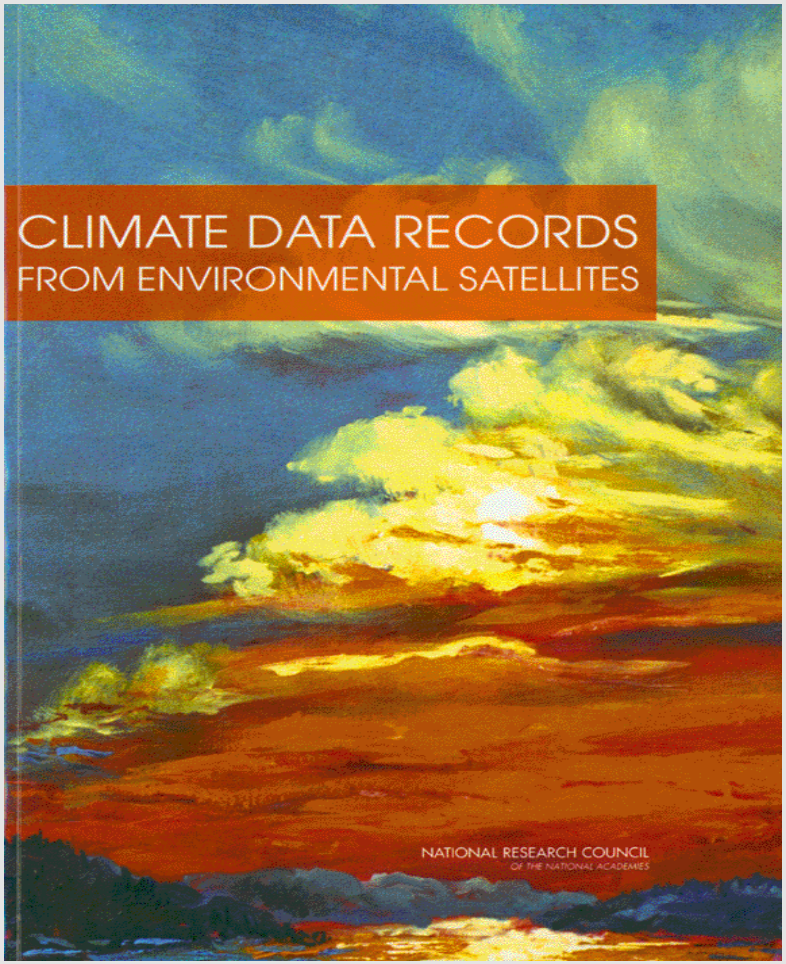
- What is Climate Data Record (CDR) and NOAA's CDR Program (CDRP) at NCEI (formerly NCDC)?
- Why are NOAA CDRs good for Climate Reanalysis?
- How NOAA CDRs are produced, sustained, archived, and distributed?
- Current operational CDRs and some application examples.
- Future opportunity & summary

What Are CDRs?

- "A **Climate Data Record (CDR)** is a time series of measurements of sufficient length, consistency, and continuity to determine climate variability and change" (US National Academy of Sciences, 2004)
- Application Specified definitions:
  - **Fundamental CDR (FCDR)**: Calibrated/homogenized observations for a family of sensors together with the ancillary data used to calibrate them (such as Radiance/Brightness Temperature) − Applications**: e.g., Data Assimilation for Radiance/BT**
  - **Thematic CDR (TCDR)**: Geophysical variables derived from FCDRs; may be generated by blending satellite observations, in-situ data, and model output (such as Sea Surface Temperature) − Applications: **e.g., Model evaluation , climate analysis, and data assimilation for geophysical variables**
  - **Climate Information Record (CIR):** A time series derived from TCDRs and related data that provides specific information about an environmental phenomena of importance to science and society (such as Arctic Sea Ice Extent) – Applications: **e.g., Model evaluation and climate analysis.**

NOAA CDR Program (CDRP) is Well-Grounded in Science and External Expert Guidance

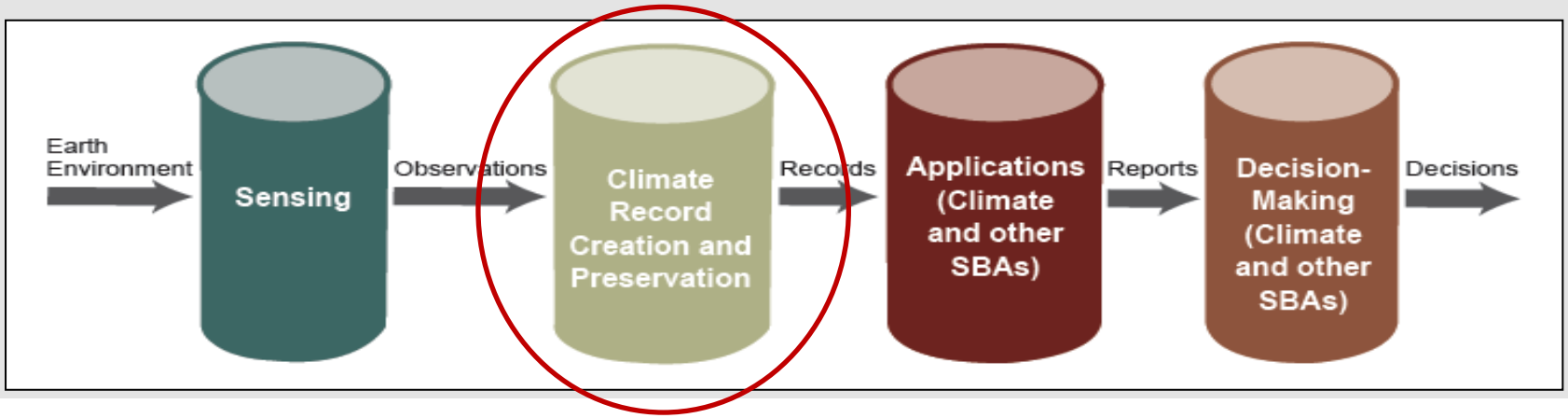
- National Research Council (NRC) of US National Academy of Sciences (NAS) (2004, 2008)
- Global Change Research Program (CCSP, 2006)
- WMO/Global Climate Observing System (GCOS,2003)
- US EOP/Office of Science and Technology (OSTP), NOAA/NESDIS guidance



NOAA CDRP's Mission Objective

- To develop and implement a robust, transparent, sustainable, and scientifically defensible approach for developing, producing, preserving, and provisioning CDRs generated from NOAA operational satellite observations and in-situ measurements.

- To provide end-to-end CDR data service to various user sectors (academy, commercial, government, and the public).



NOAA's CDR Requirements

The Climate Data Record model shown provides a pathfinder for most NCDC products

A Climate Data Record is a time series of measurements of sufficient length, consistency, and continuity to determine climate variability and change (NRC, 2004).

To achieve this, a Climate Data Record shall be:

Accessible	Continuously Assessed/ Improved	Extensible	Preserved	Reproducible	Scientifically defensible	Sustainable	Transparent
Available; Easily obtained, affordable, and understand-able.	Evaluated on a scheduled basis, with the possibility of better methodologies being incorporated	Forward compatible in accommodating new data from existing or new instruments; Able to be adapted for use by others	Secured in perpetuity	Producing consistent results within machine rounding errors	Based on testable hypotheses and methodologies that have been objectively and openly peer-reviewed	Having the potential for long-term maintenance; capable of being continued without exhausting available resources	Openly accountable in every respect

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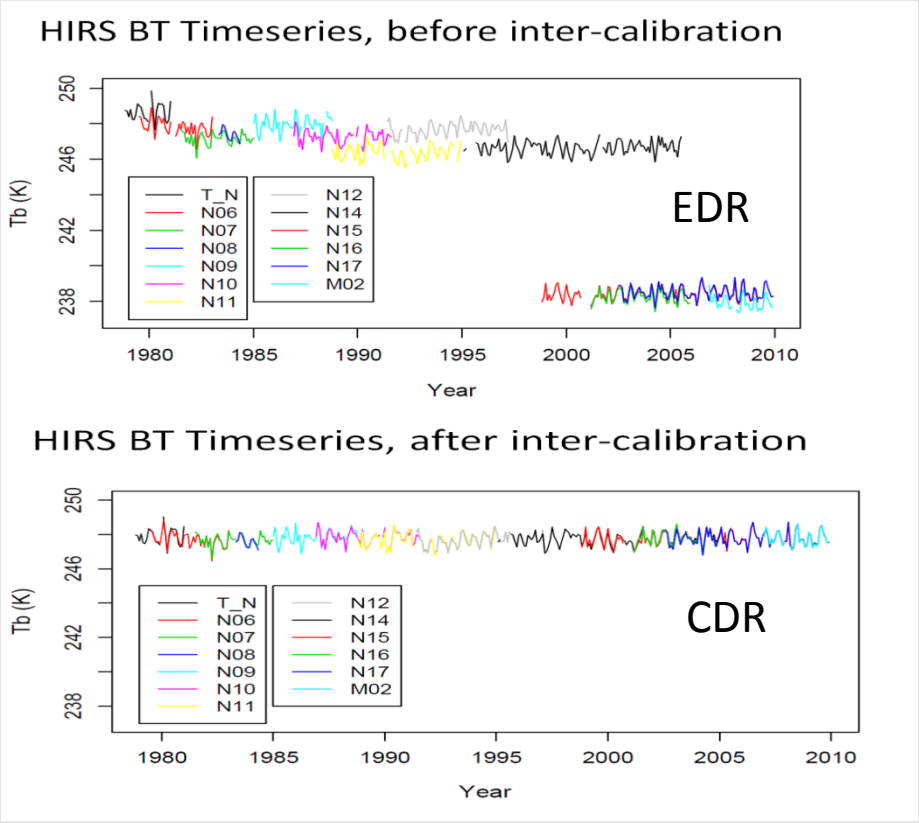
- Current operational CDRs and some application examples.
- Future opportunity & Summary

Why Are NOAA CDRs Unique?

- NOAA's satellite CDRs comprise its longest record of global operational satellite measurements. By applying knowledge gathered over time about instruments' performance and sensor characteristics, the data are reprocessed to create consistent and homogenized long-term records.
- NOAA CDRs are sustained in an operational environment, which is critical for supporting decision-making in a changing climate, and thus for the world's resilience to climate changes and variability.

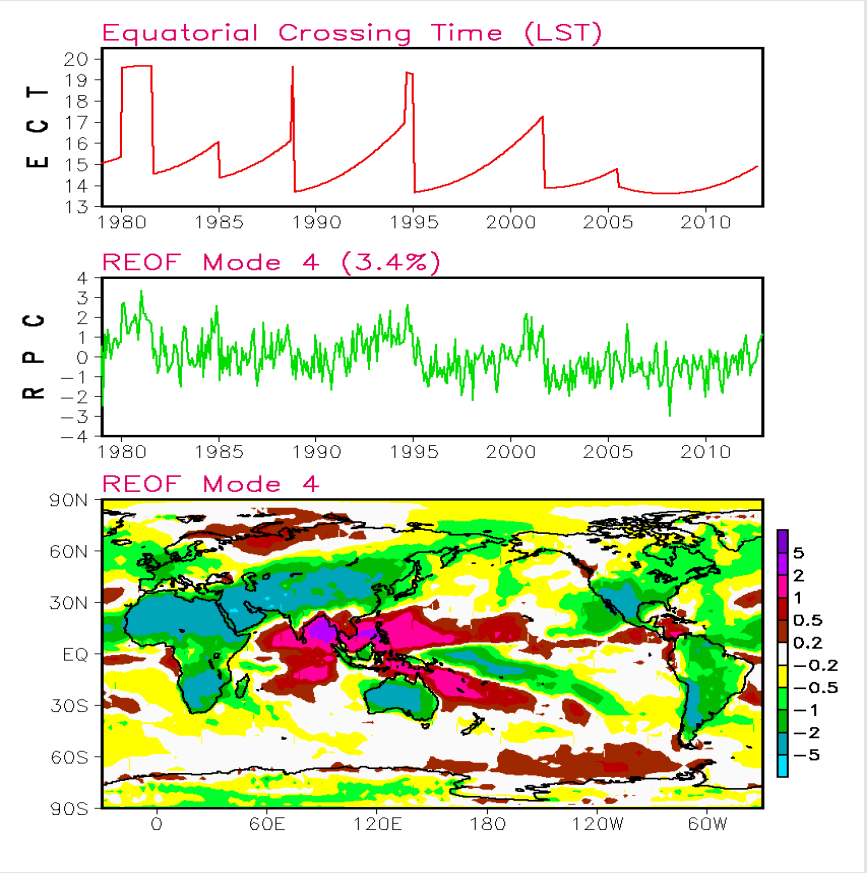
Inter-calibration and Homogenization in CDRs Reduce Artifacts Imparted by Observing Systems in EDR, Facilitating Meaningful Comparisons in Space and Time.



Example of EDR Deficiency for Climate Analysis

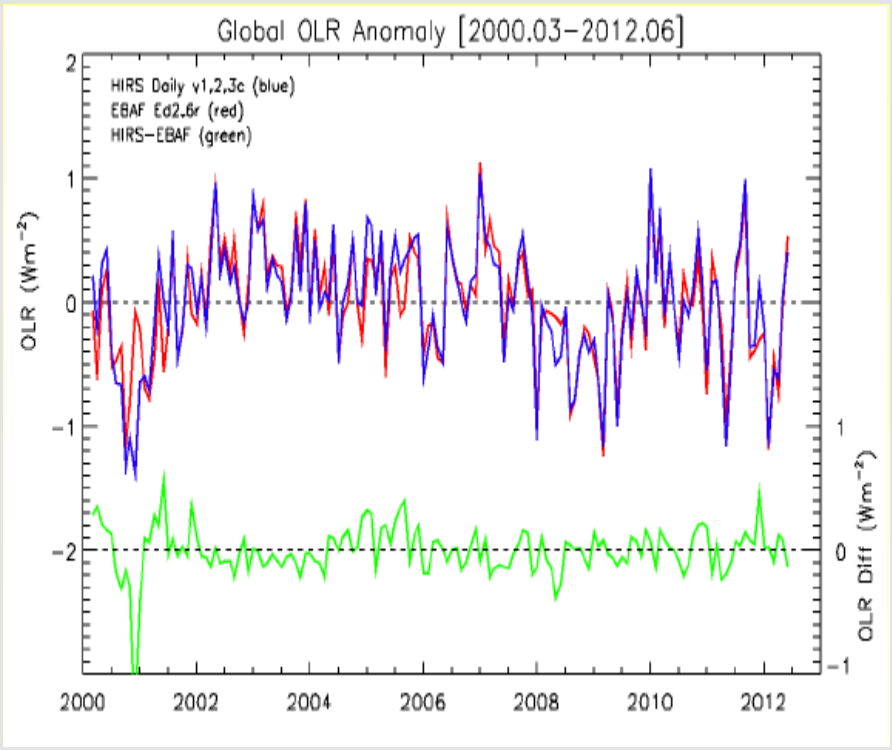
- Evident effect of Equator Crossing Time (ECT) on the Mode 4 of Rotated EOF for monthly AVHRR OLR (EDR) anomaly.
- Mode 4 account for 3.4% of total variance.
- Spatial distribution of Mode 4 shows strange patterns (e.g., substantial land-sea contrasts).

Orbit Drift Effect on the EOF of AVHRR/OLR (EDR) Anomaly



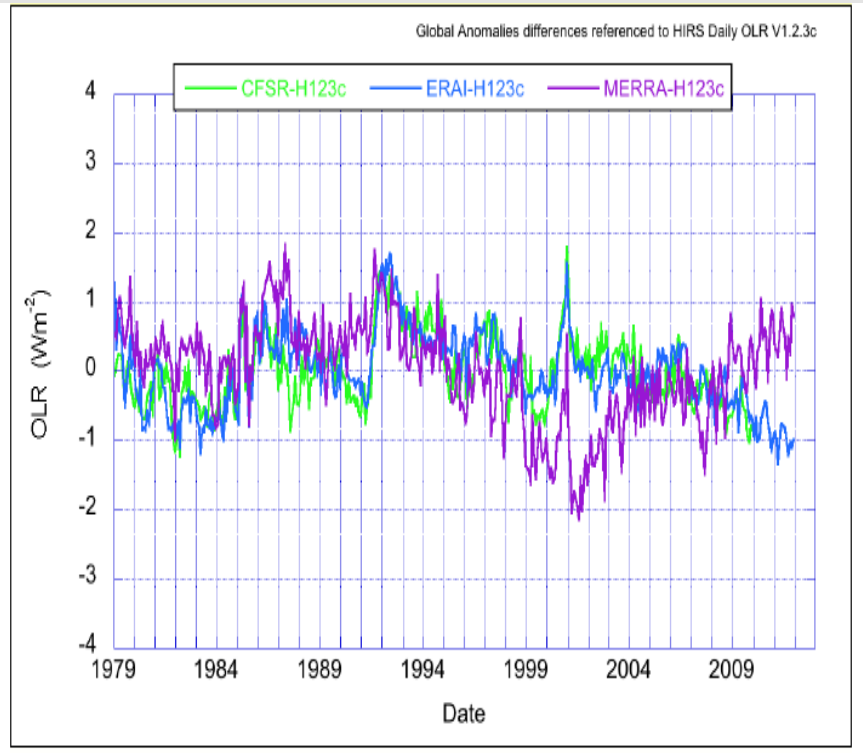
Example of CDR Advantage for Climate Analysis

Difference of Global OLR Anomalies
(Long-term HIRS CDR vs Short-term CERES CDR)

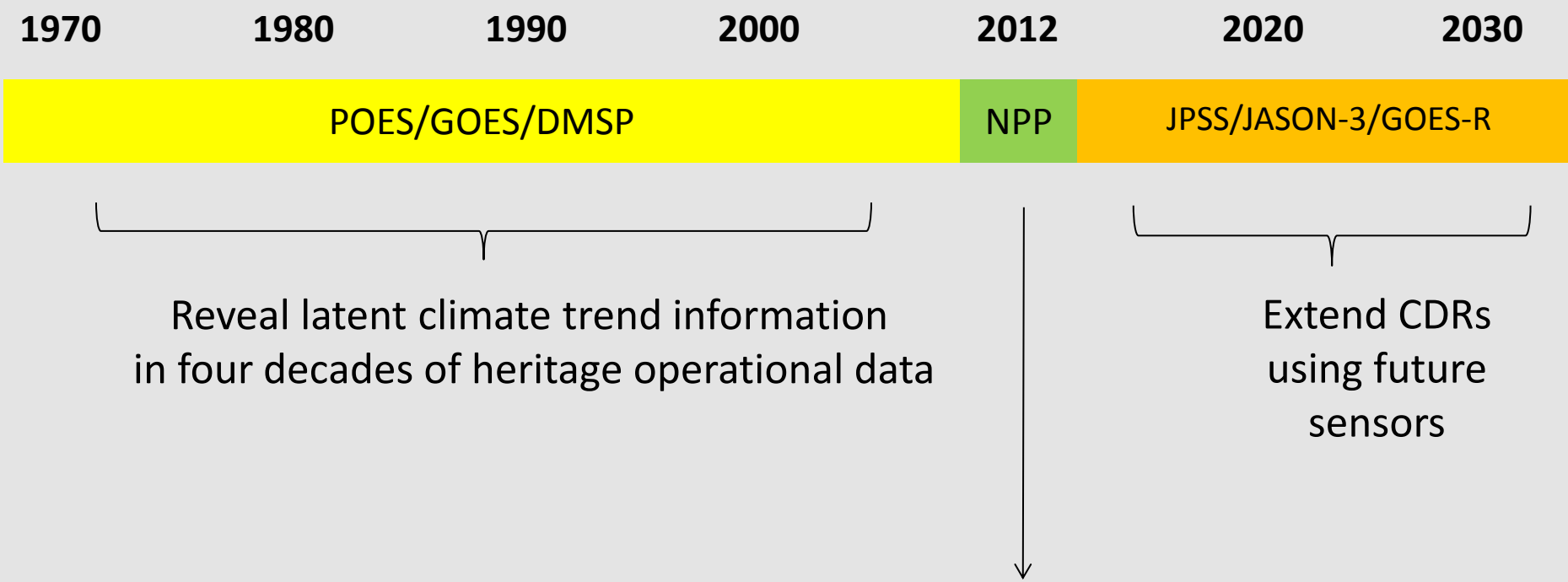


Slope of OLR anomalies diff = 0.03 ± 0.09 Wm^{-2}/decade with 2-sigma

Difference of Global OLR Anomalies
(Reanalysis minus HIRS CDR)

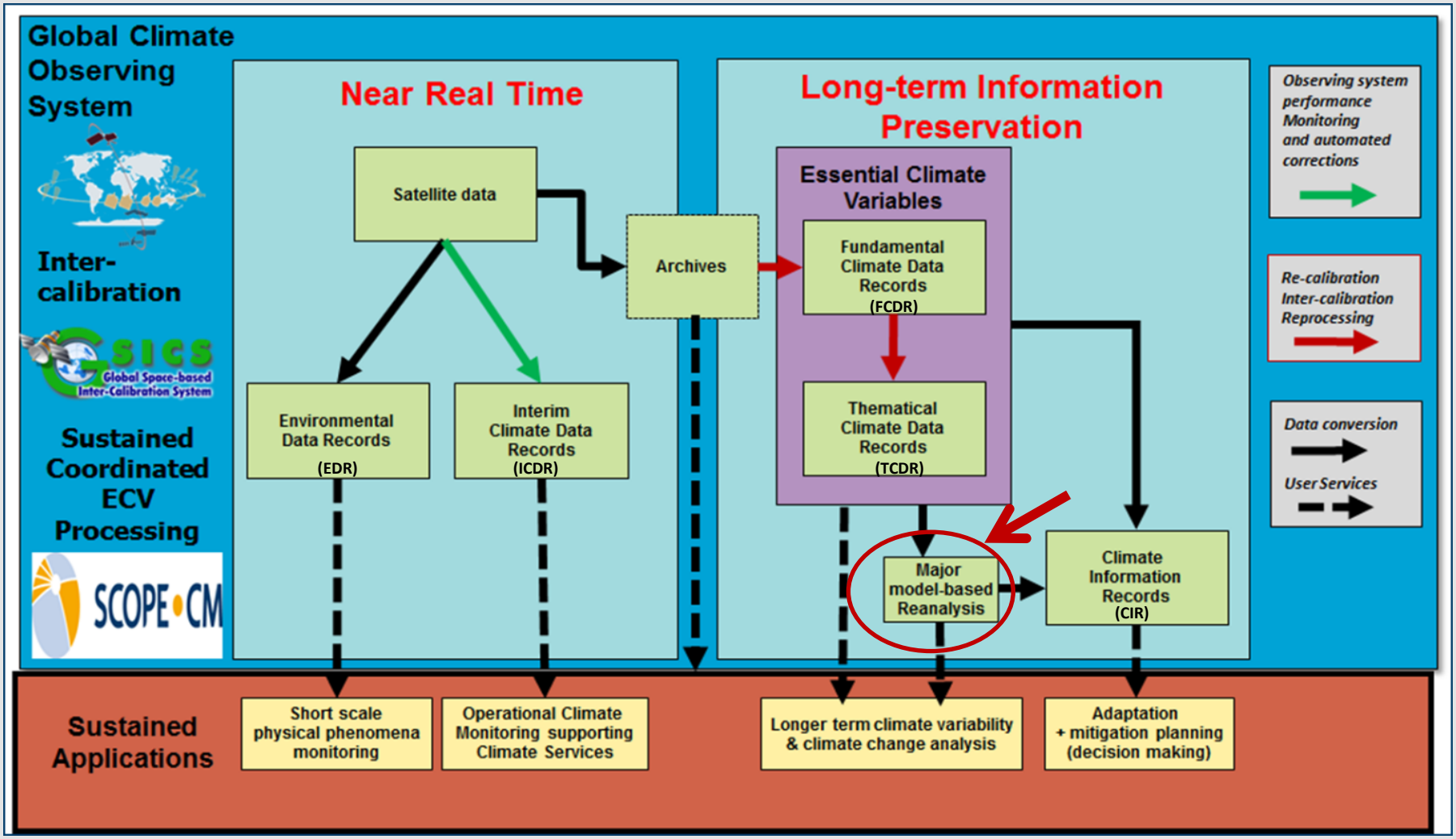


Operational CDRs Will Cover Three Major NOAA Satellite Epochs



NOAA CDRs Sustain Climate Information

(critical for improving science understanding of climate changes and the world's resilience to climate changes and variability)



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Three Phase R2O Process of NOAA CDRs

1. ID

- **Initial Development (ID)**: Through grant and contract, PIs develop algorithm, source code, dataset, metadata, and documentation
- PI brings the product to at least Maturity Level-4

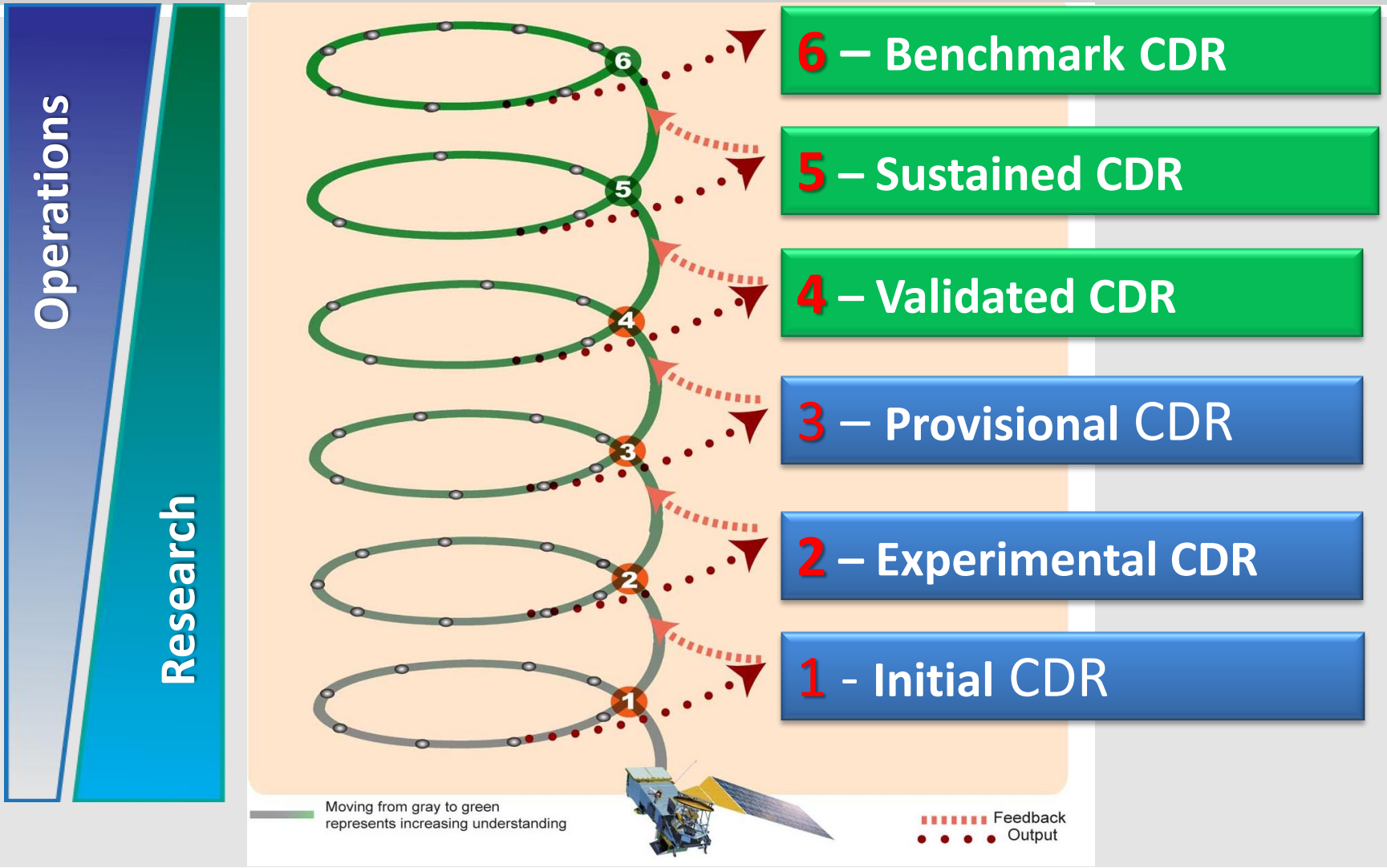
2. IOC

- **Initial Operational Capability (IOC)**: The dataset, metadata, source code and documentation are quality checked, archived and made openly and transparently available for public access.
- Original PI provides operational support and maintenance/updates

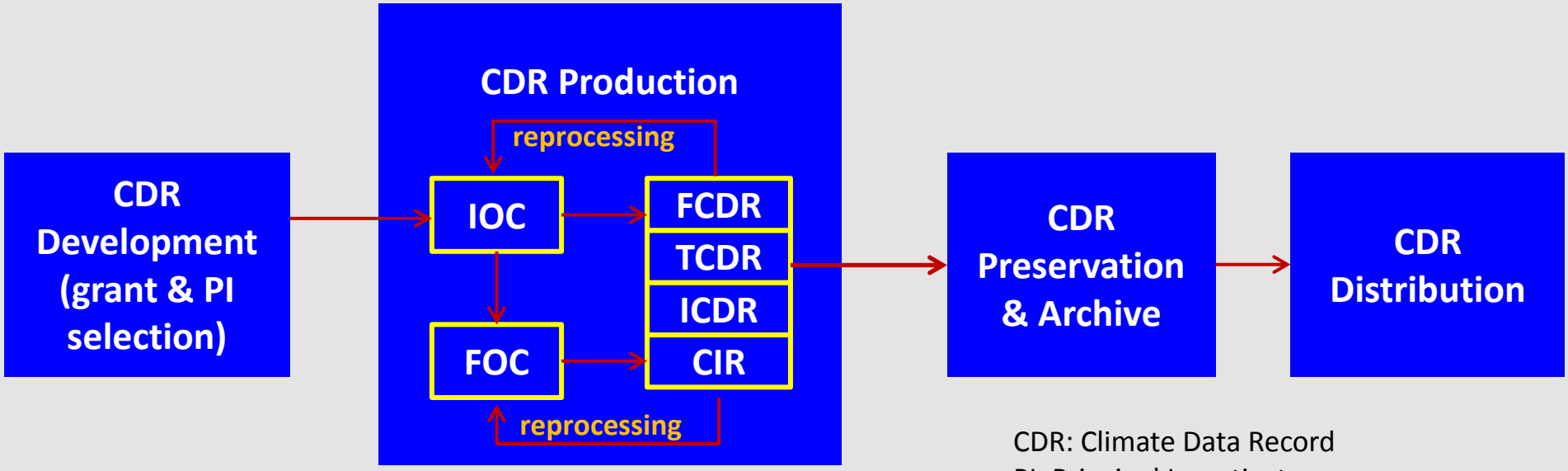
3. FOC

- **Full Operational Capability (FOC)**: CDR is systematically and routinely generated by NOAA using codes and systems that conform to the NOAA CDR Program's IT security, coding and documentation standards
- CDR operational support and maintenance/updates can be accomplished independent of the original PI [Maturity Level-6]

6-Level Maturity Model of NOAA CDRs

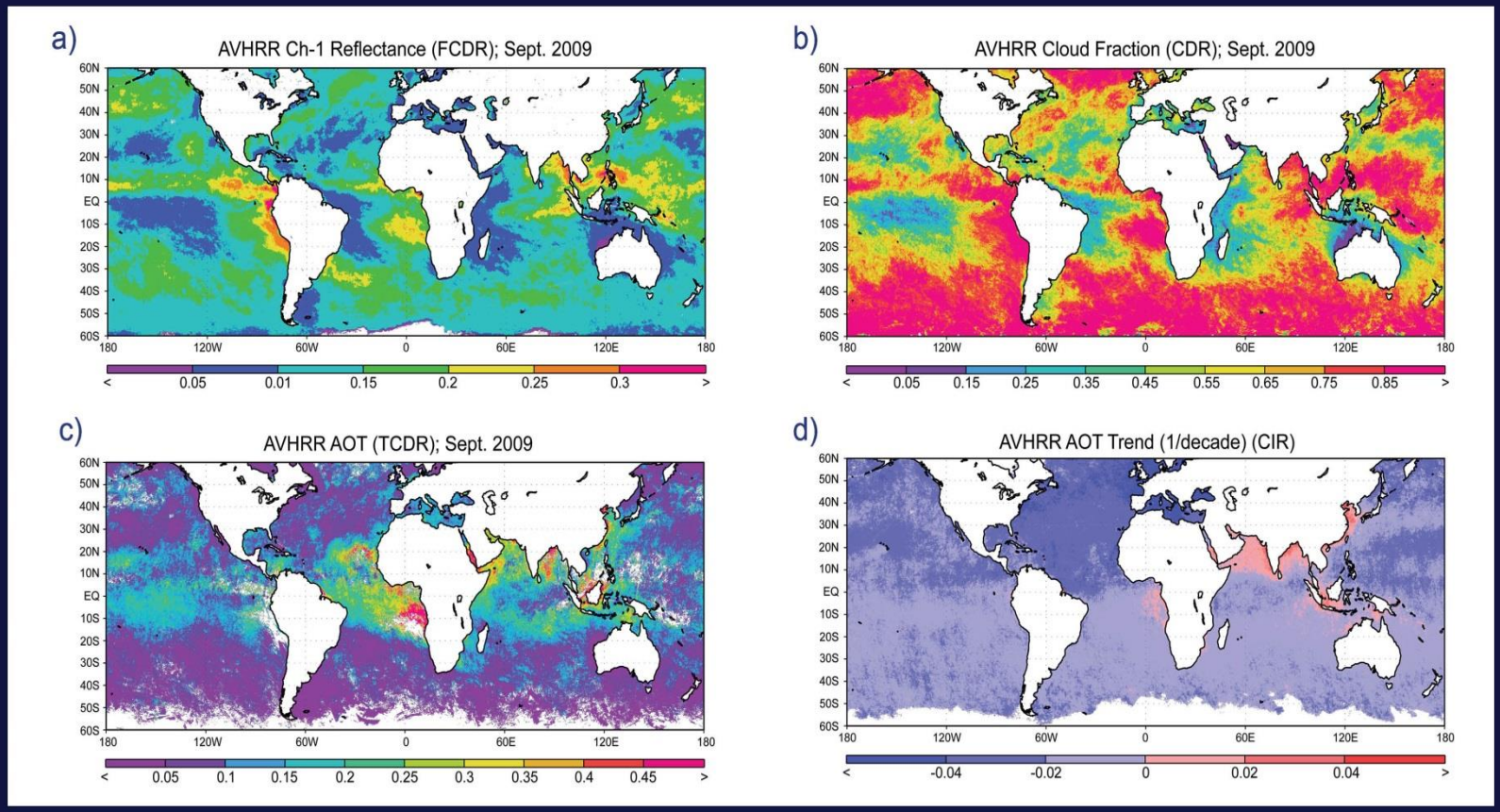


Development, Production, Archive, and Distribution of CDRs



CDR: Climate Data Record
PI: Principal Investigator
IOC: Initial Operational Capability
FOC: Full Operational Capability
FCDR: Fundamental CDR
TCDR: Thematic CDR
ICDR: Interim CDR
CIR: Climate Information Record

A Suite of Products
(FCDR→CDR→TCDR→CIR)



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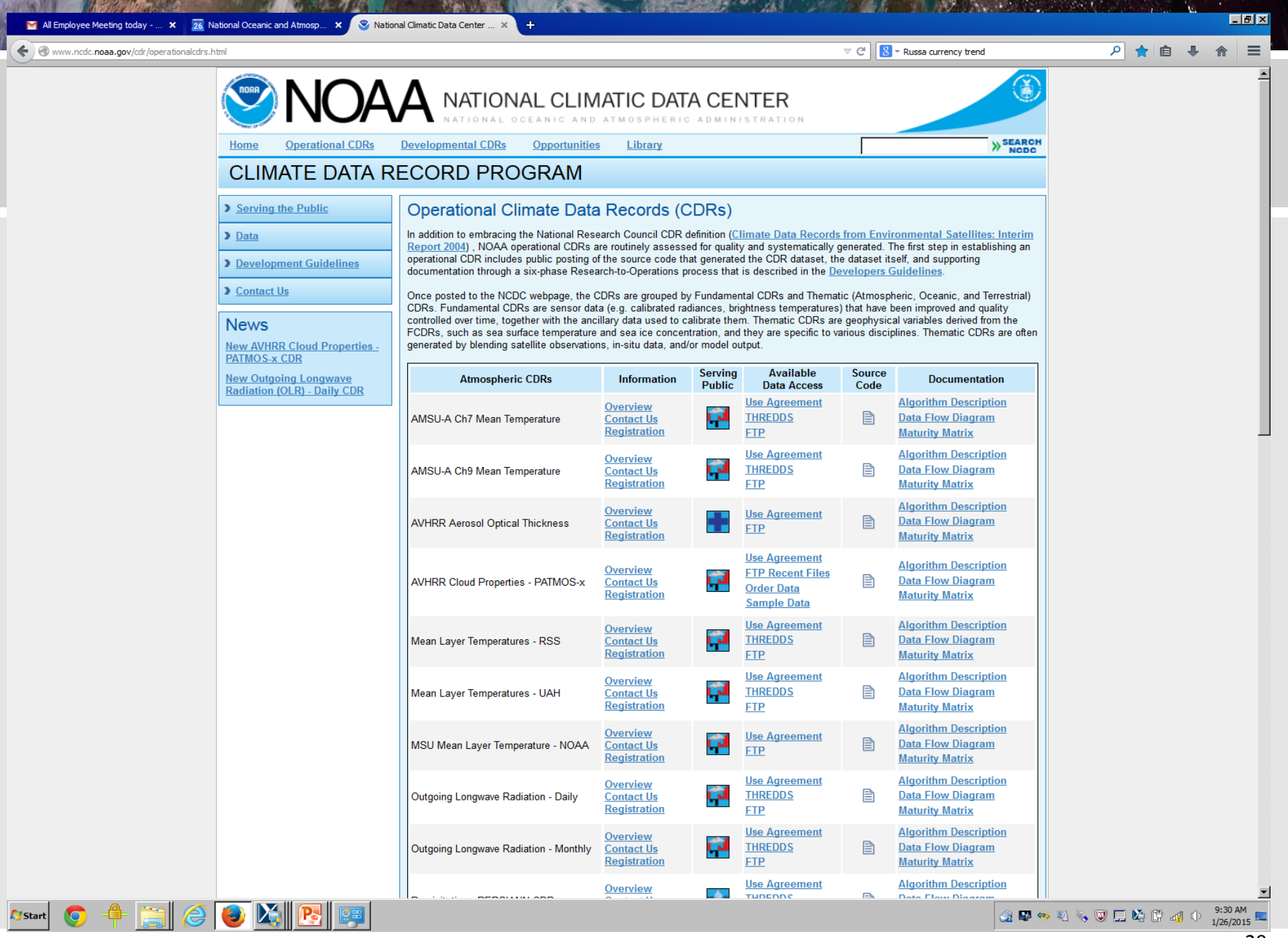
Inventory of NOAA CDR Products

24 CDRs in Ops. as of 2014 http://www.ncdc.noaa.gov/cdr

Current IOC Operational CDRs			
FCDR	**Atmosphere**	**Ocean**	**Land**
• AVHRR Reflectance – PATMOS-x	• MW Mean Layer Temperature (4)	• SST (OISST & Pathfinder)	• Surface Reflectance (AVHRR)
• HIRS Brightness Temperature (BT)	• Precipitation (PERSIANN)	• Sea Ice Concentration	• Snow Cover Extent (NH)
• SSMI(S) BT (CSU,RSS)	• Cloud Properties (PATMOS-x)		• NDVI (AVHRR)
• VIIRS C-RDR (*)	• OLR (HIRS & GridSat)		• LAI/FAPAR (AVHRR)
• MSU/AMSU BT	• Aerosol Optical Thickness (AVHRR)		
• GOES BT (GridSat)			

Research-to-Operation CDRs (work-in-progress)			
FCDR	**Atmosphere**	**Ocean**	**Land**
• Solar Irradiance (total & spectral)	• Earth Radiation Budget (ISCCP-ERB)	• Surface Fluxes	• Geo-Surface Reflectance
	• Precipitation (GPCP & CMORPH, NEXRAD)	• Sea Level Height	• Snow Concentration
	• Cloud (ISCCP & CERES)		
	• Ozone (ESRL & CPC)		

*http://www.ncdc.noaa.gov/data-access/satellite-data/satellite-data-access-datasets/c-rdr-viirs


All Employee Meeting today - ...
National Oceanic and Atmosp...
National Climatic Data Center ...
www.ncdc.noaa.gov/cdr/operationalcdrs.html
Russa currency trend
NOAA
NATIONAL CLIMATIC DATA CENTER
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Home
Operational CDRs
Developmental CDRs
Opportunities
Library
SEARCH NCDC
CLIMATE DATA RECORD PROGRAM
Serving the Public
Data
Development Guidelines
Contact Us
News
New AVHRR Cloud Properties - PATMOS-x CDR
New Outgoing Longwave Radiation (OLR) - Daily CDR
Operational Climate Data Records (CDRs)
In addition to embracing the National Research Council CDR definition (Climate Data Records from Environmental Satellites: Interim Report 2004) , NOAA operational CDRs are routinely assessed for quality and systematically generated. The first step in establishing an operational CDR includes public posting of the source code that generated the CDR dataset, the dataset itself, and supporting documentation through a six-phase Research-to-Operations process that is described in the Developers Guidelines.
Once posted to the NCDC webpage, the CDRs are grouped by Fundamental CDRs and Thematic (Atmospheric, Oceanic, and Terrestrial) CDRs. Fundamental CDRs are sensor data (e.g. calibrated radiances, brightness temperatures) that have been improved and quality controlled over time, together with the ancillary data used to calibrate them. Thematic CDRs are geophysical variables derived from the FCDRs, such as sea surface temperature and sea ice concentration, and they are specific to various disciplines. Thematic CDRs are often generated by blending satellite observations, in-situ data, and/or model output.
Atmospheric CDRs
Information
Serving Public
Available Data Access
Source Code
Documentation
AMSU-A Ch7 Mean Temperature
Overview Contact Us Registration
Use Agreement THREDDS FTP
Algorithm Description Data Flow Diagram Maturity Matrix
AMSU-A Ch9 Mean Temperature
Overview Contact Us Registration
Use Agreement THREDDS FTP
Algorithm Description Data Flow Diagram Maturity Matrix
AVHRR Aerosol Optical Thickness
Overview Contact Us Registration
Use Agreement FTP
Algorithm Description Data Flow Diagram Maturity Matrix
AVHRR Cloud Properties - PATMOS-x
Overview Contact Us Registration
Use Agreement FTP Recent Files Order Data Sample Data
Algorithm Description Data Flow Diagram Maturity Matrix
Mean Layer Temperatures - RSS
Overview Contact Us Registration
Use Agreement THREDDS FTP
Algorithm Description Data Flow Diagram Maturity Matrix
Mean Layer Temperatures - UAH
Overview Contact Us Registration
Use Agreement THREDDS FTP
Algorithm Description Data Flow Diagram Maturity Matrix
MSU Mean Layer Temperature - NOAA
Overview Contact Us Registration
Use Agreement FTP
Algorithm Description Data Flow Diagram Maturity Matrix
Outgoing Longwave Radiation - Daily
Overview Contact Us Registration
Use Agreement THREDDS FTP
Algorithm Description Data Flow Diagram Maturity Matrix
Outgoing Longwave Radiation - Monthly
Overview Contact Us Registration
Use Agreement THREDDS FTP
Algorithm Description Data Flow Diagram Maturity Matrix
Start
9:30 AM
1/26/2015

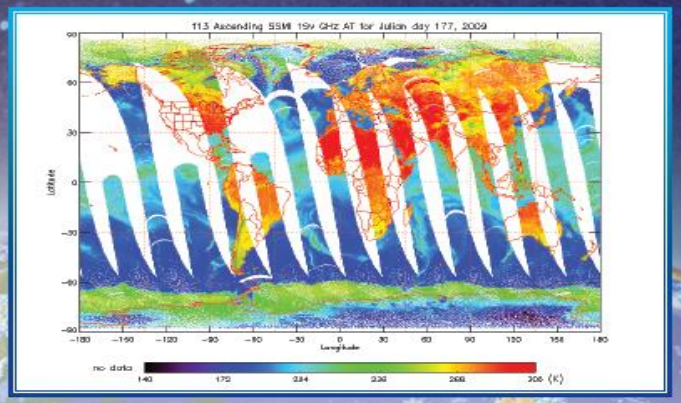
Example of FCDR

NOAA'S NATIONAL CLIMATIC DATA CENTER

NOAA's Climate Data Record (CDR) Program

SSMI(S) Brightness Temperature
Colorado State University

SSMI(S) - CSU



SSMI(S) Climate Data Record Specifications

- Global Coverage
- Resolution varies by Channel (14 x 16 km, 45 x 70 km)
- 101 Minutes Per Orbit
- 1987–Present
- Updated Daily

Inputs to the *SSMI(S)* Climate Data Record

- Navy-NESDIS Special Sensor Microwave Imager/Sounder [SSMI(S)] Antenna Temperature

Some Uses of the *SSMI(S)* Climate Data Record

- Input into Precipitation Products
- Determining Sea Surface Winds
- Calculating Sea Ice Extent and Snow Cover
- Long-term Global Climate Applications
- Estimating Cloud Liquid Water

SSMI(S) Climate Data Record

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

Climate Data Record Program Information

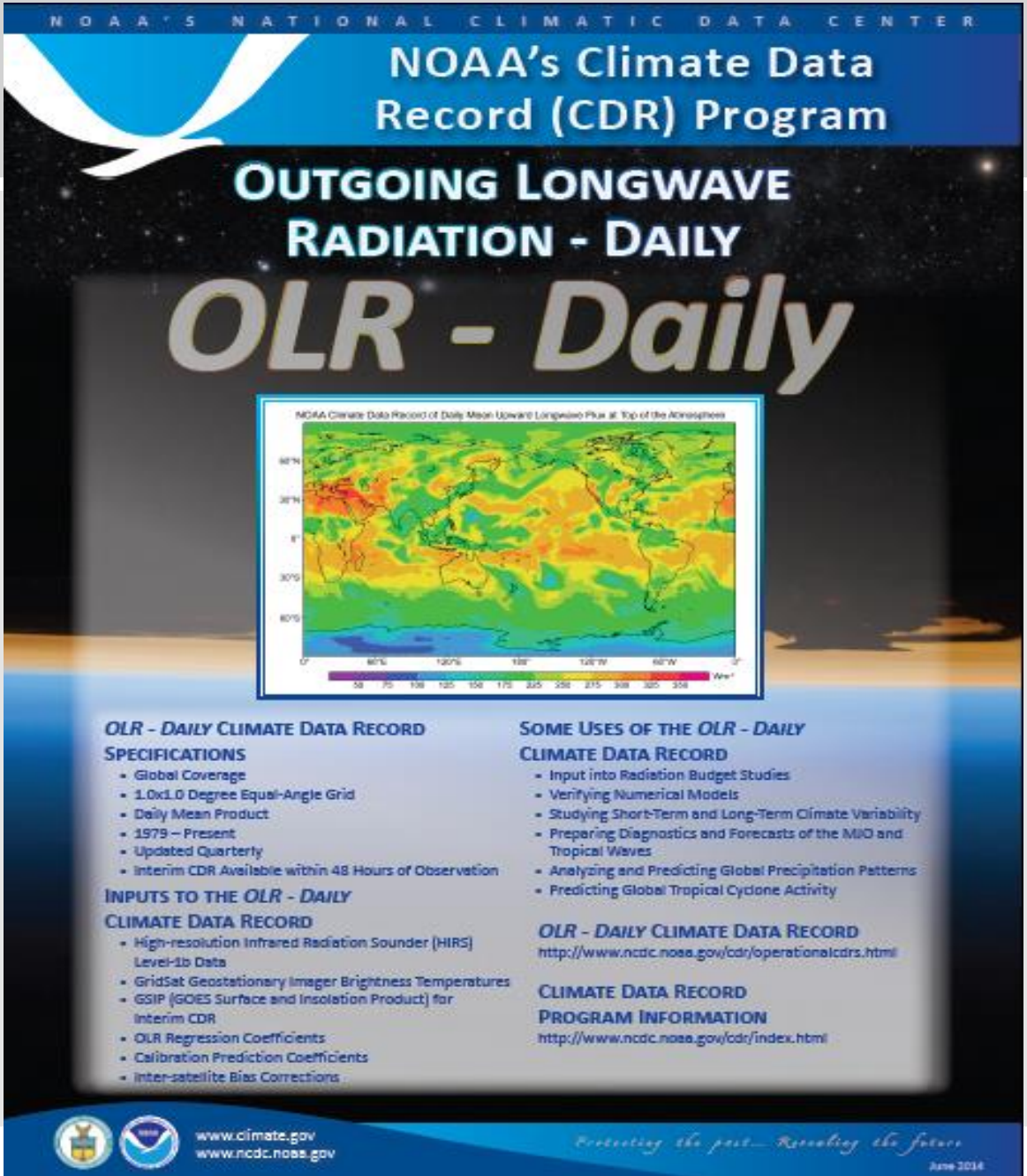
http://www.ncdc.noaa.gov/cdr/index.html

www.climate.gov
www.ncdc.noaa.gov

Protecting the past... Revealing the future

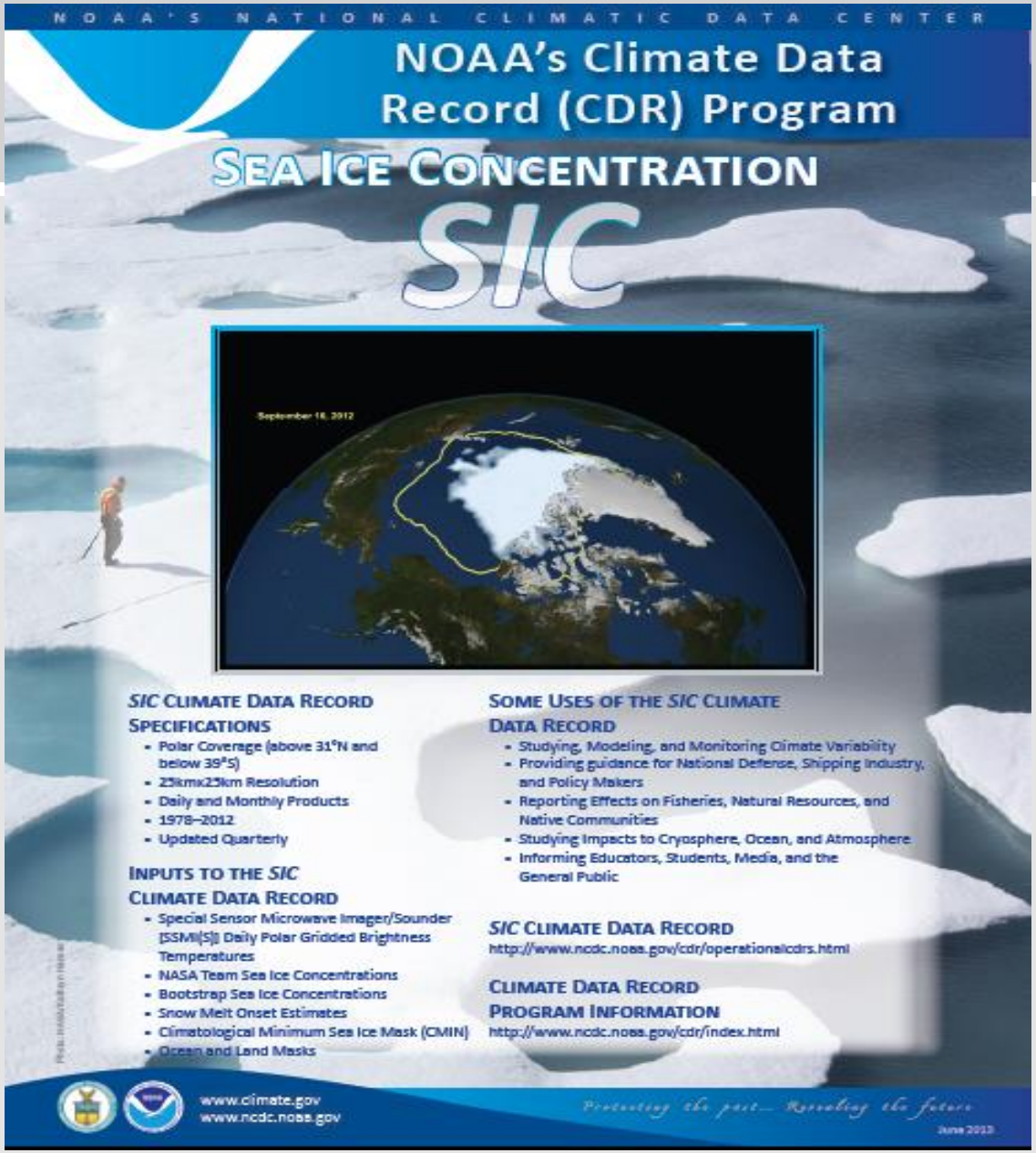
July 2013

Example of Atmospheric CDR (CMIP5/Obs 4MIPS Candidate)

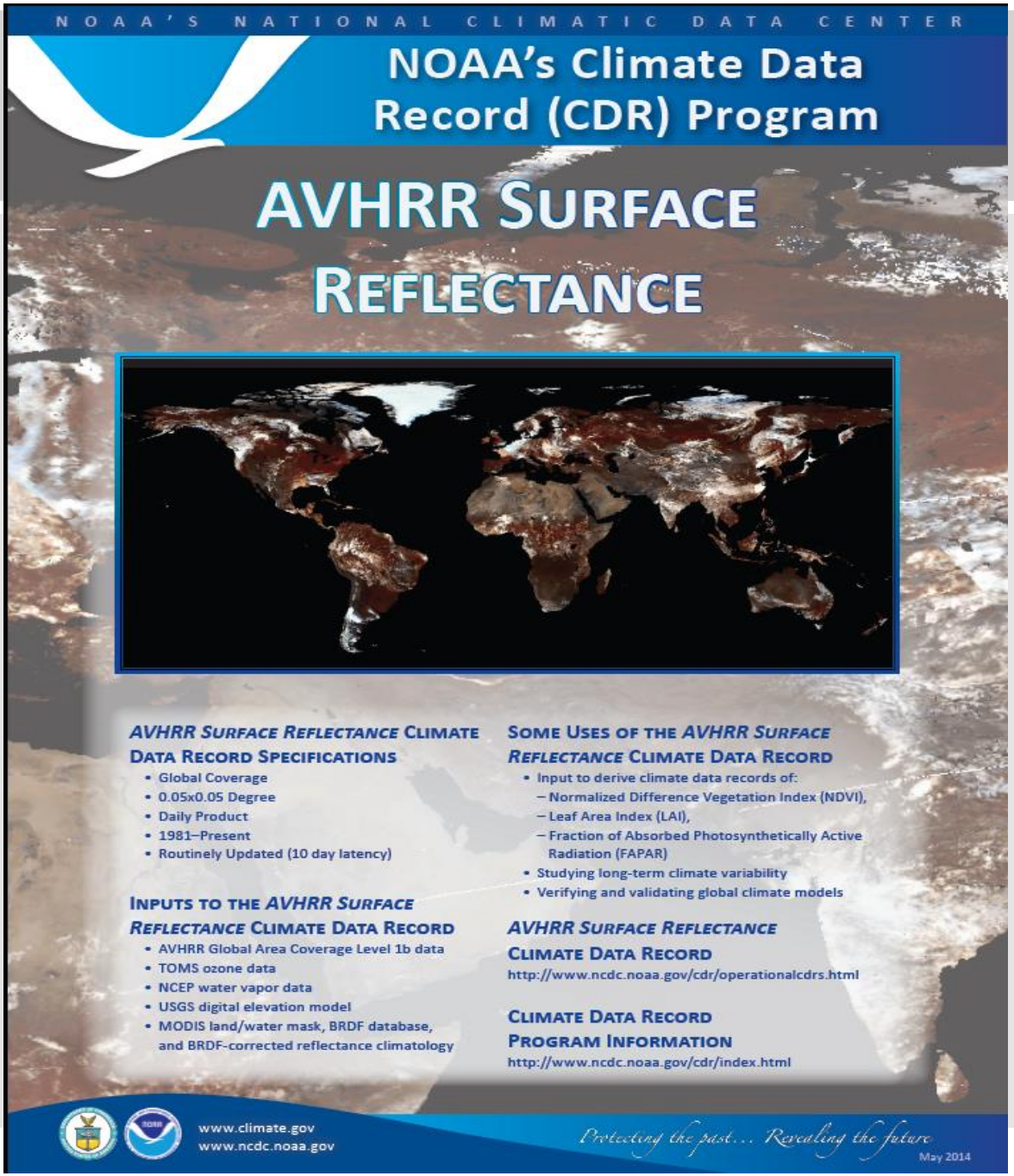


Example of Ocean CDR (CMIP5/Obs4MIPS Candidate)

Example of Ocean CDR (CMIP5/Obs4MIPS Candidate)

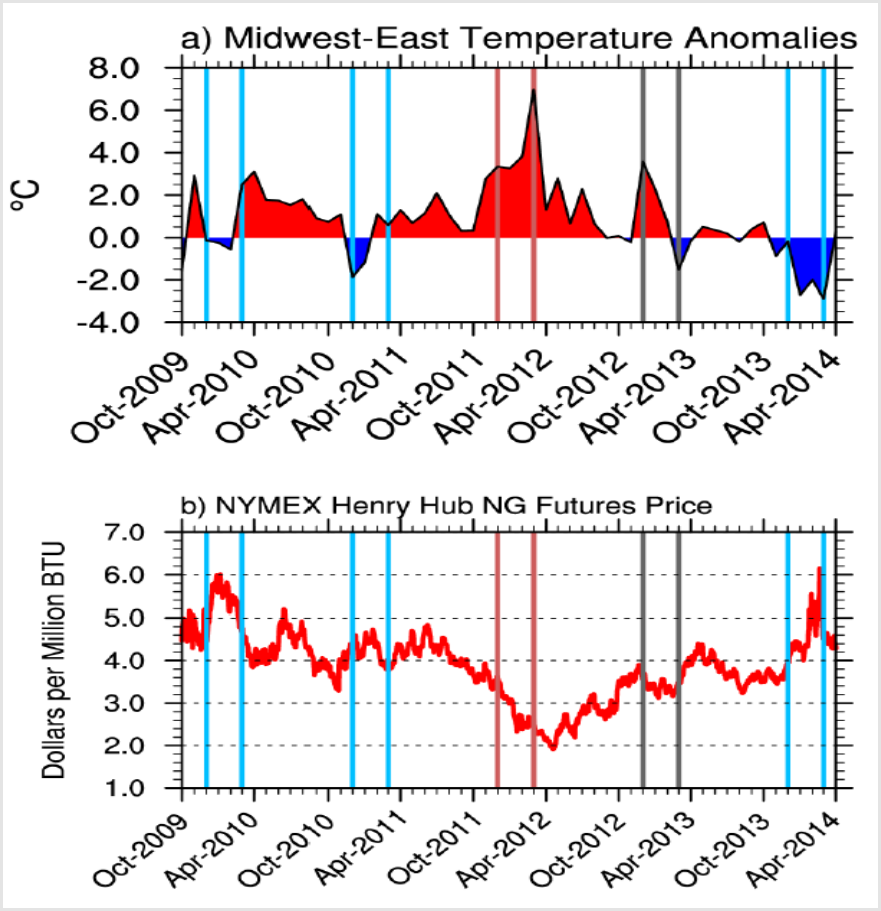


Example of Land CDR

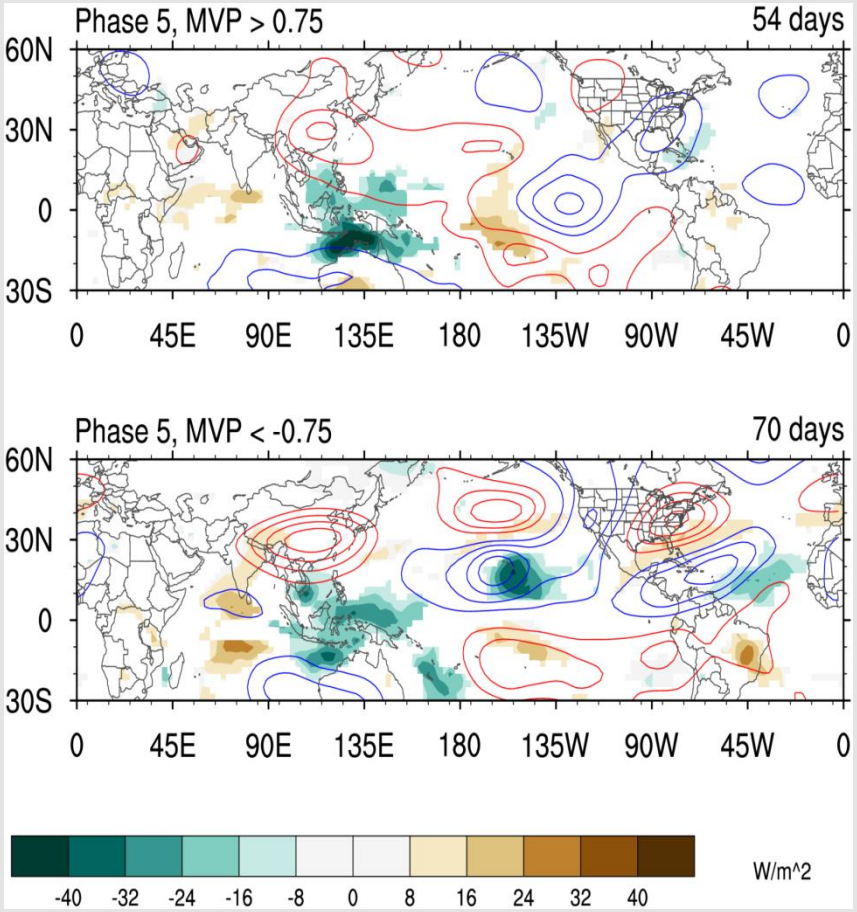


Examples of CDR Applications

(MVP Index CIR Application-Provides Commercial Benefit)



MJO Based Reanalysis Using MVP & OLR CDR

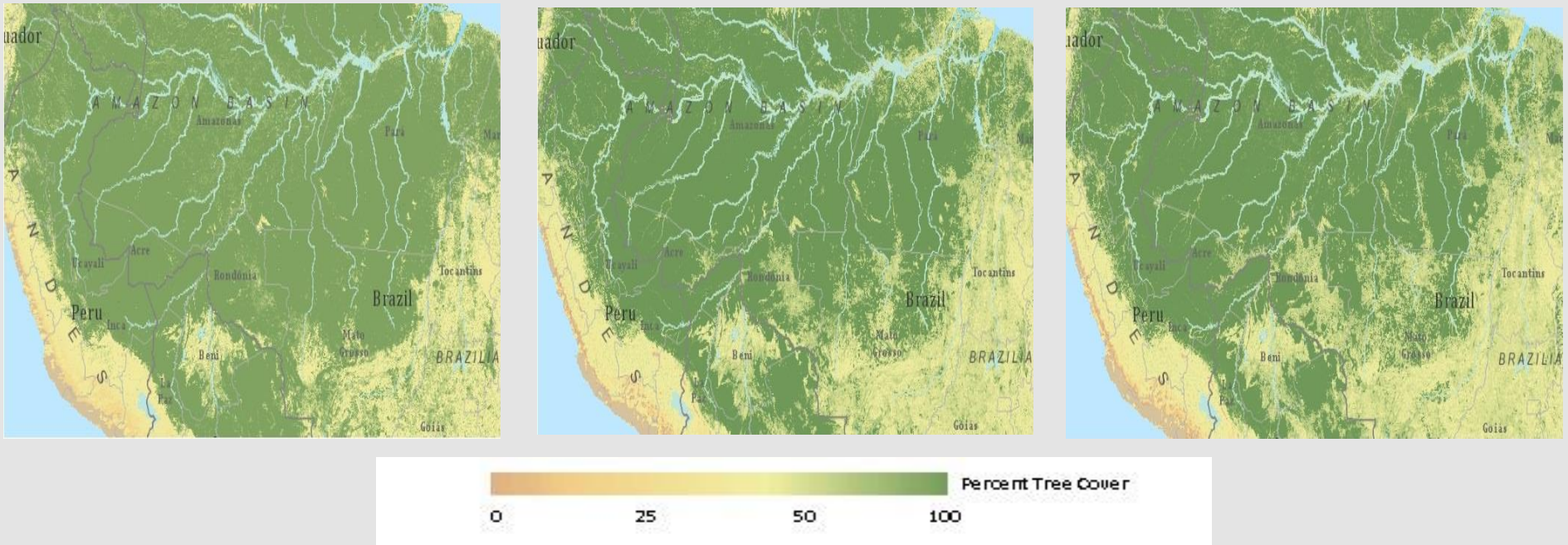


(Courtesy of Dr. Carl Shreck)

CDRs Supporting Resource Management
(Example: Forest Change Detection Using NDVI/LAI CDRs)

Percent Tree Cover Change in Amazon Basin

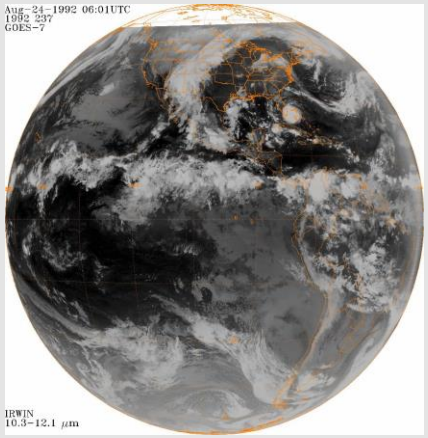
1990 (AVHRR CDRs) | **2000 (MODIS Data)** | **2010 (MODIS Data)**



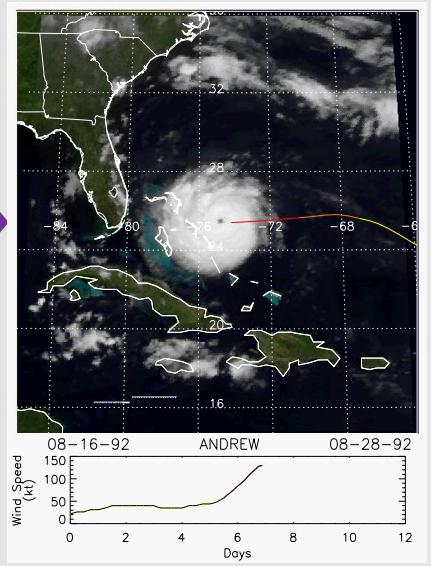
(Courtesy of Dr. Eric Vermote)

Records-to-Information: Hurricane Trends

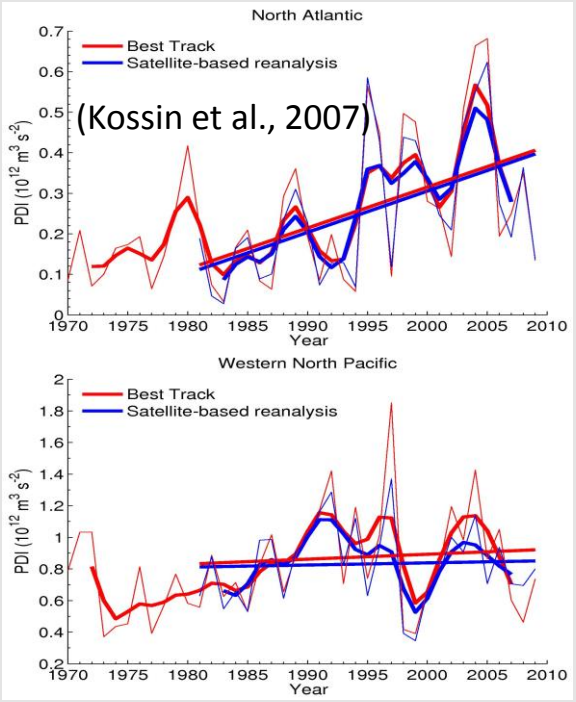
GridSat FCDR



Blended TCDR



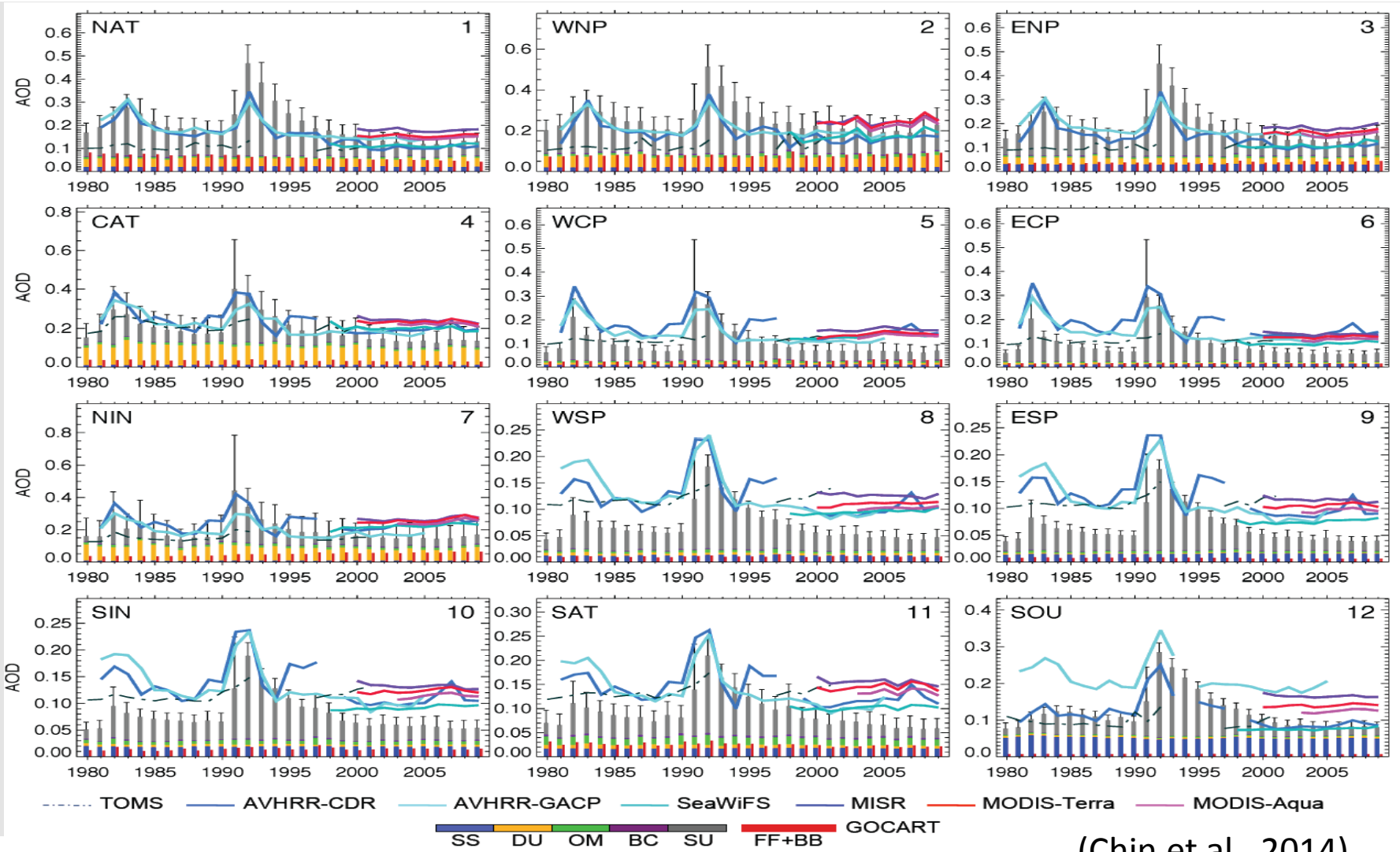
CIR



(decision support information)

Comparison and Model Improvement

(AeroCom: AVHRR AOT CDR vs GOCART Model)



(Chin et al., 2014)

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Future Opportunity and Collaboration

- Distribute CDRs to climate reanalysis community to promote wider discovery and use (e.g., identify use cases).
- Increase interoperability of CDRs with other data types (e.g., reanalysis data, health, business, agriculture) and multiple CDRs applied to targeted societal issues.
- Extend the operational CDRs seamlessly using new NOAA satellite observations from Suomi-NPP/JPSS and GOES-R series.
- Identify collaboration projects for potential CDR Program sponsorship.

Summary

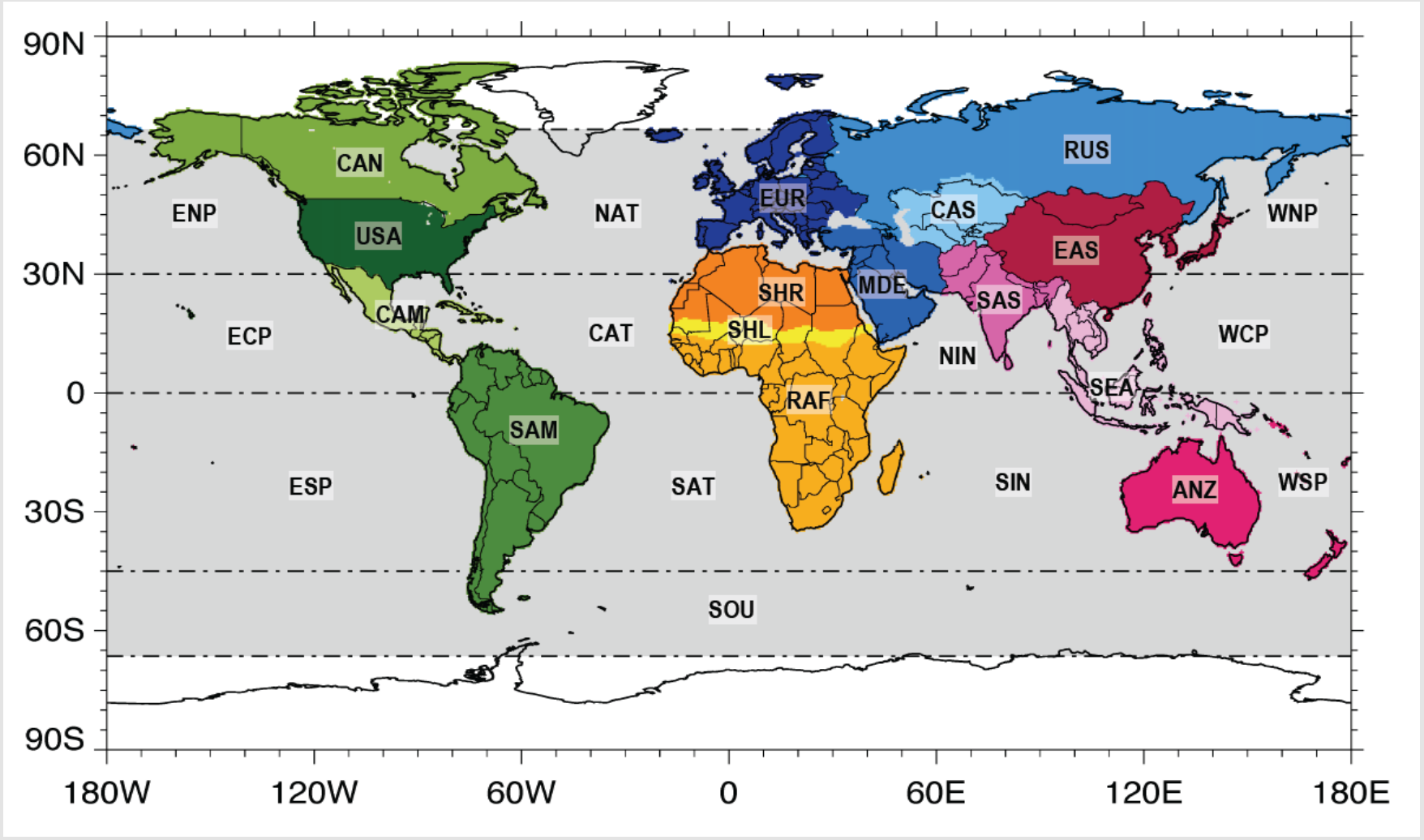
- The NOAA CDR Program is **well-grounded in science**, is reaching out to address **users' needs**, and continues to improve **open & transparent** stewardship practices for satellite data, non-satellite data and blended products.
  - Includes CIRs, and interim CDR products.
- The NOAA CDR Program at NCEI is **now sustaining 24 satellite data CDRs in operations**, and is preparing CDR data, algorithms, workflows, and documentation for future deployment to a climate information platform and for broader user applications.
  - CDRs include **not just the data, but the algorithms, workflows, and documentation as well**.
- CDRP is seeking collaboration on using CDR products for end-user applications (including climate re-analysis application).

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

Thank you!

Questions?

Backup Slides



CDRs Supporting Farming and Agribusiness

Example: historical context

- 5 km resolution, "wall-to-wall" (globally)
- Historical record from 1981- to current
- Collateral products
  - Surface Reflectance
  - Leaf Area Index (LAI)
  - FPAR (photosynthetically active radiation)

Primary U.S. corn and soybean region

2012 drought depicted by Vegetation Index CDR (July 17)