21st Annual Symposium on Operational Environmental Satellite Systems

Paper #: 14A.5

NOAA Long-term Operational Satellite Climate Data Records (CDRs): Production, Products, Application, and Service



NOAA
National Satellite and Information Service

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AMS-2025 Annual Meeting, New Orleans, LA, USA
(2025-01-16; 11:45-12:00 am)

Outline

- What is a Climate Data Record (CDR)
- Why CDR?
- NOAA's Satellite CDRs
  - Development & production
  - Products, applications, and services
- Challenges
- Summary
- Acknowledgement

What is a CDR?

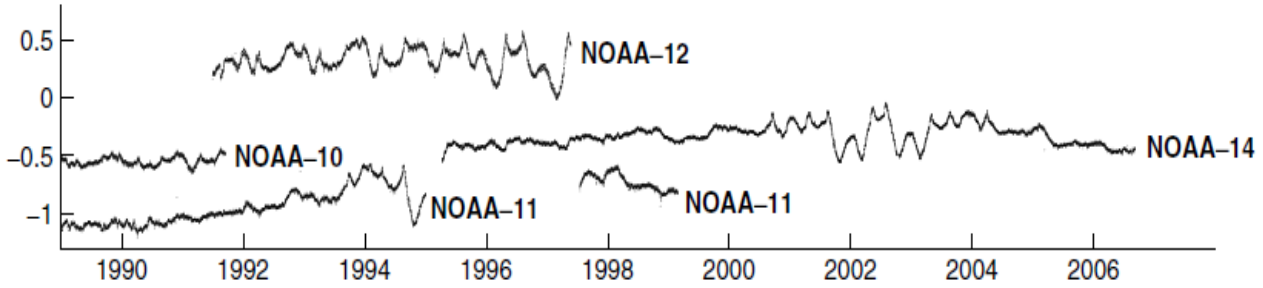
A CDR is a time series of measurements of sufficient length, consistency, and continuity to determine climate variability and change [NRC, 2004].

A CDR is also a recalibrated data!

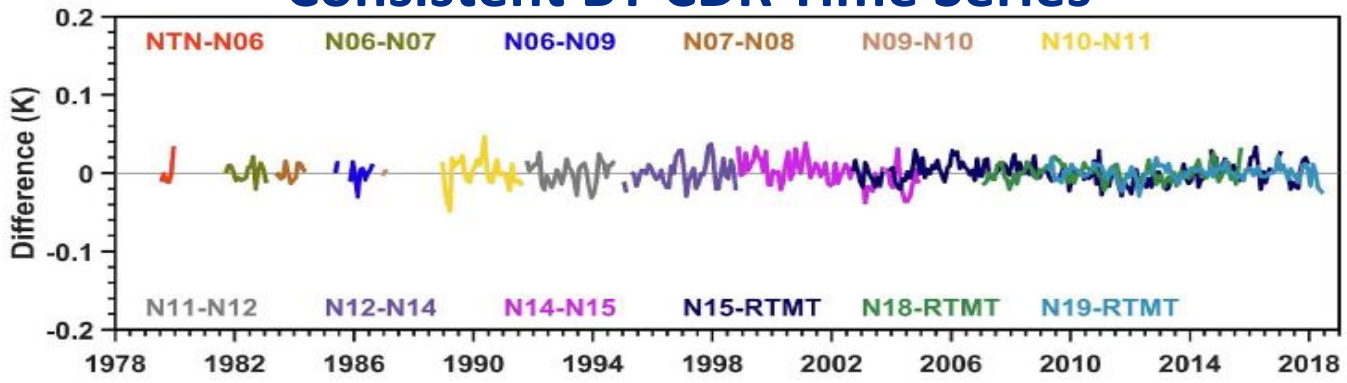
BT CDR adjustments include:

1) diurnal drift
2) calibration drift
3) channel frequency differences
4) incident angle differences
5) warm target temperature effects

In-Consistent SDR Time Series



Consistent BT CDR Time Series



A CDR is also a reprocessed data!

Reprocessed means updated ……

calibration,

assumptions,

constraints,

models,

algorithms,

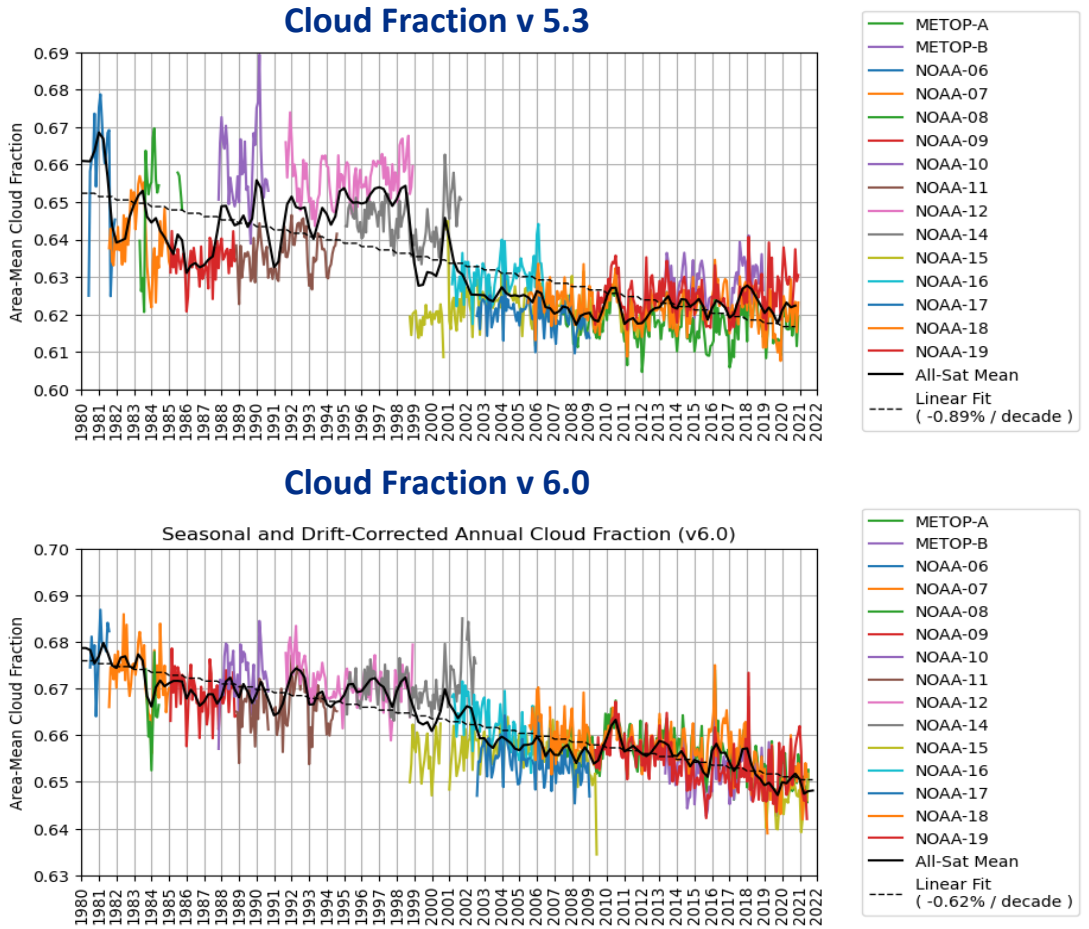
ancillary data,

understanding,

requirements,

use cases, …..

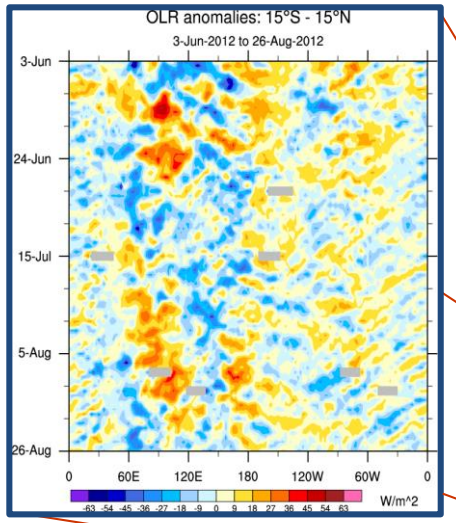
Pathfinder Atmosphere Extended (PATMOS-x) CDR

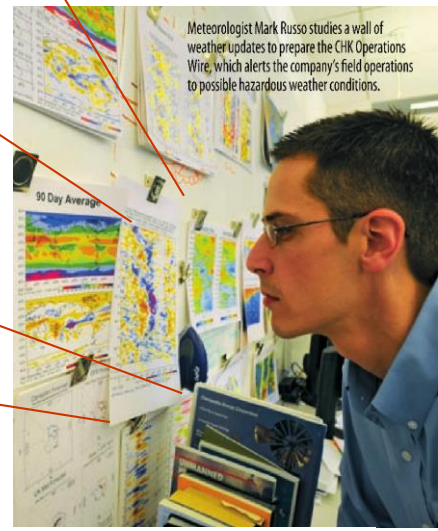


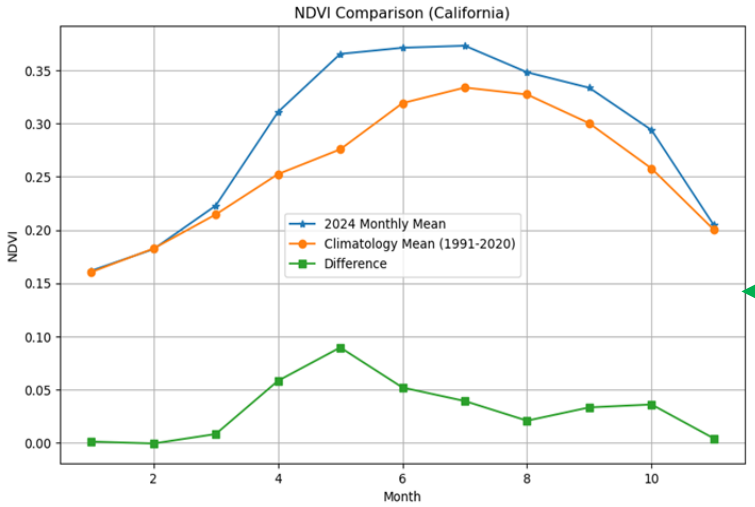
Why CDRs ?

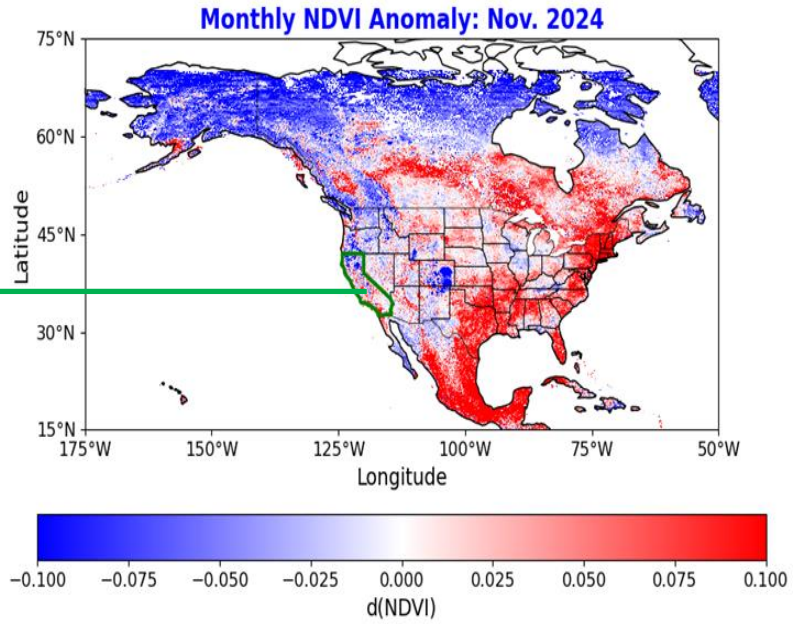
- The mandate of climate change detection and prediction is fundamentally different from that of traditional weather forecast.
- CDRs are essential for supporting the above mandate (NRC Report, 2004).

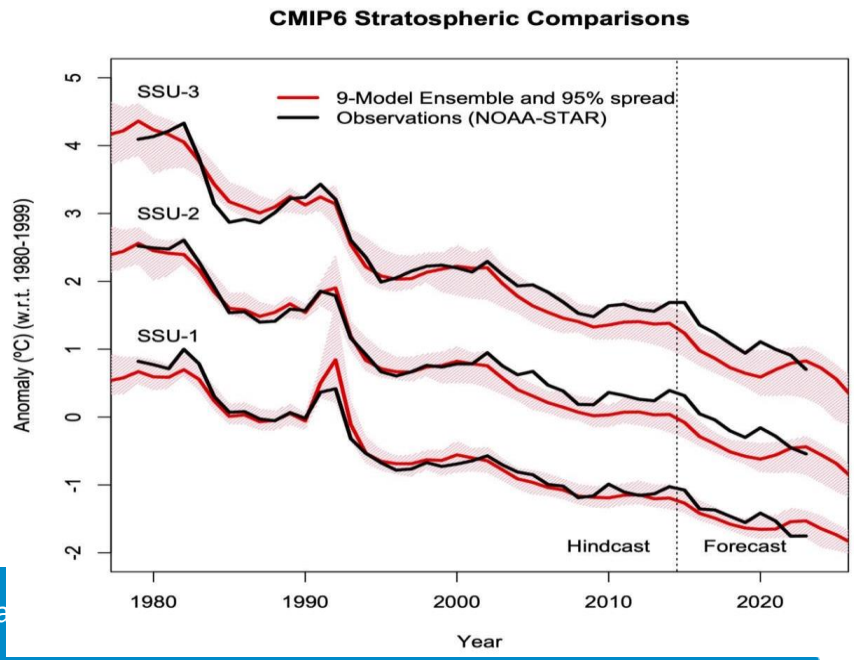
CDRs are useful data!



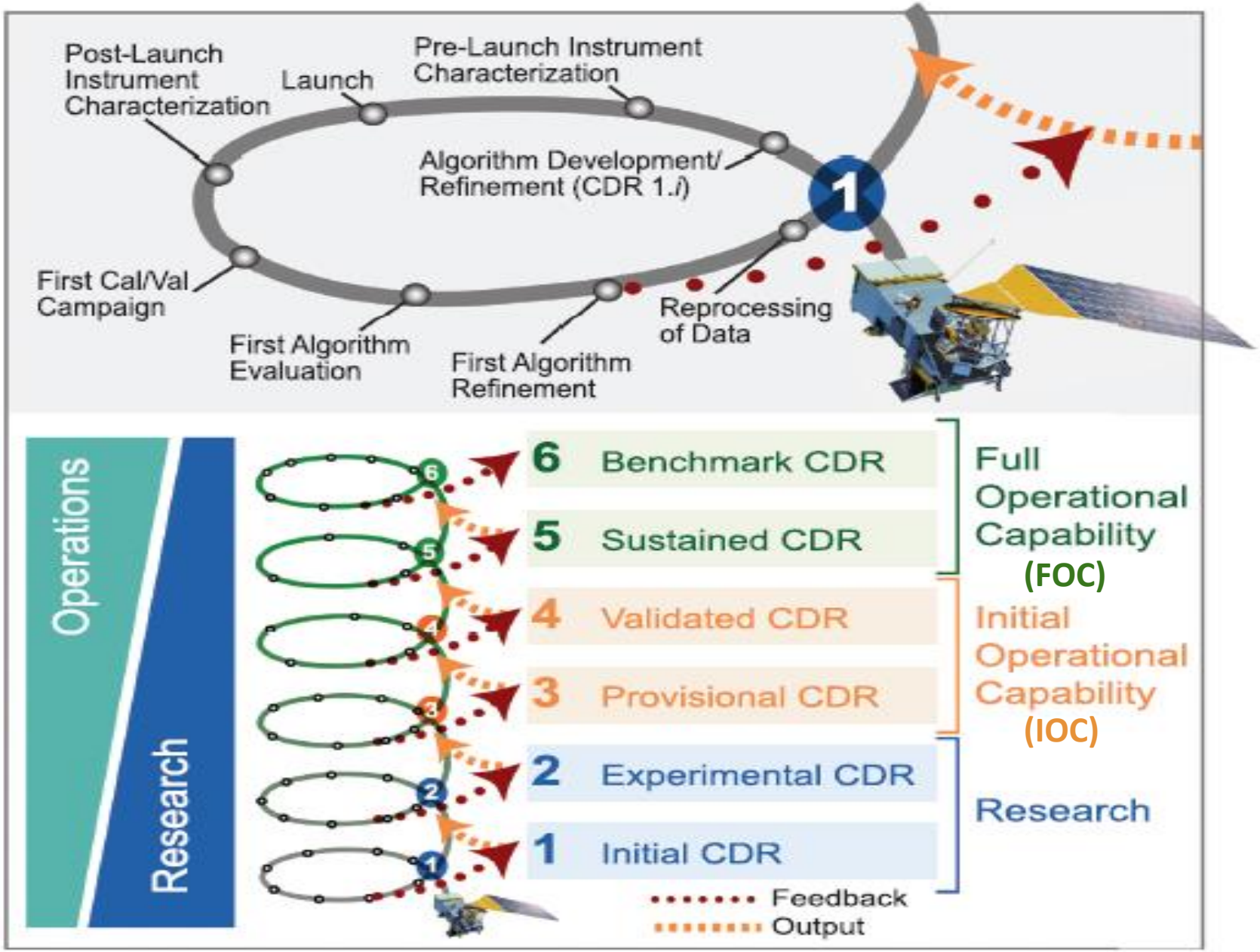




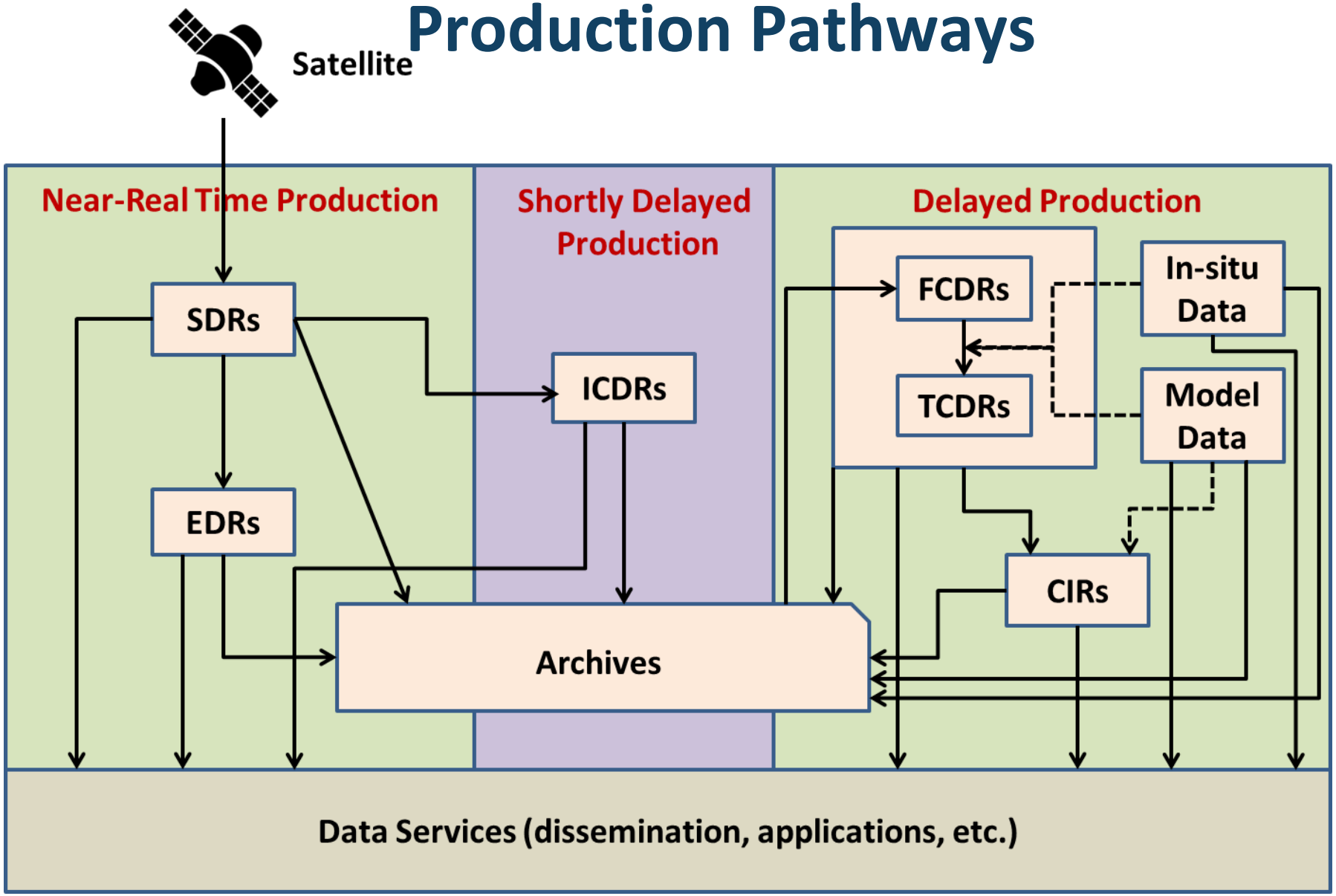




NOAA's CDRs - Development



Production Pathways

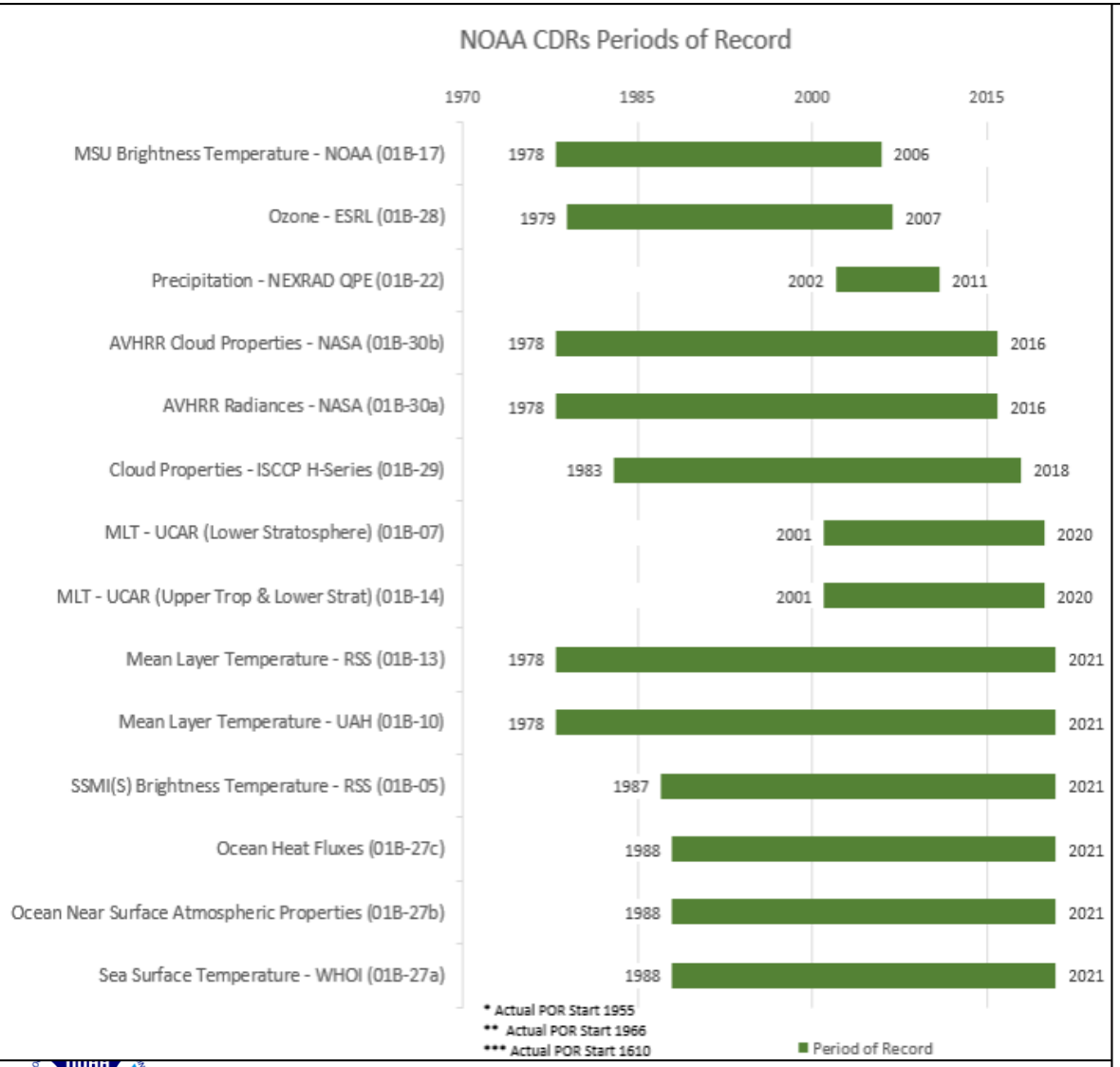


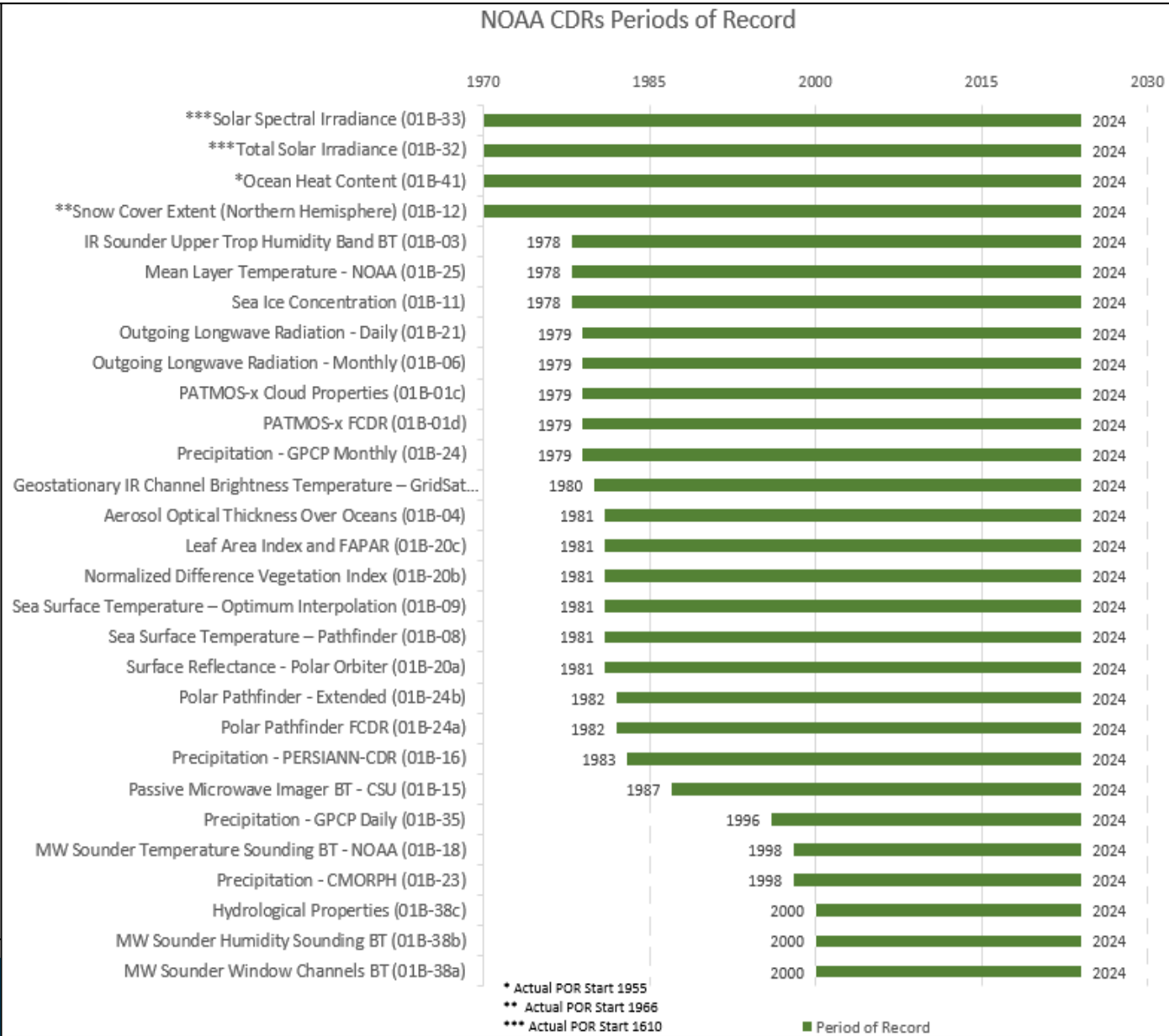
42 NOAA Operational Satellite CDR Products

(https://www.ncei.noaa.gov/products/climate-data-records)

	Atmosphere (30)	Ocean (7)	Terrestrial (5)
FCDR (16)	• 2 AVHRR Radiance CDRs • GridSat-B1 • IR Sounder UT Humidity BT • 5 Mean Layer Temp CDRs • MSU BT, SSMI/S BT, Passive MWI BT • 3 MW Sounder (H, T, W) BT		• Polar Pathfinder - Surface Reflectance
TCDR (26)	• Aerosol CDR (over ocean) • 3 Cloud CDRs (PATMOS-x, ISCCP H-Series, NASA AVHRR) • Hydrological Properties CDR • Outgoing LW Radiation (daily & monthly CDRs) • 5 Precipitation CDRs • Ozone - ESRL CDR • Total Solar & Spectral Irradiance	• 3 SST (OISST, Pathfinder, WHOI) • Global Ocean Heat Content • Sea Ice Concentration • Ocean Heat Flux • Ocean Near-Surface Properties CDRs	• NDVI CDR • LAI/FAPAR CDR • NH Snow Cover Extent CDR • Polar Pathfinder - Extended CDRs

NOAA CDRs by Period of Record





CDRs by Processing Level

Level 1C (Swath – Re- & Inter-calibrated)
MW Sounder data, Passive Microwave

Level 1G (Mapped – Re- & Inter-calibrated)
GridSat, IR UTH, PATMOS-x Clouds, Polar Pathfinder

Level 2 (Swath - Geophysical Variable)
SST (Pathfinder), Hydrological Properties

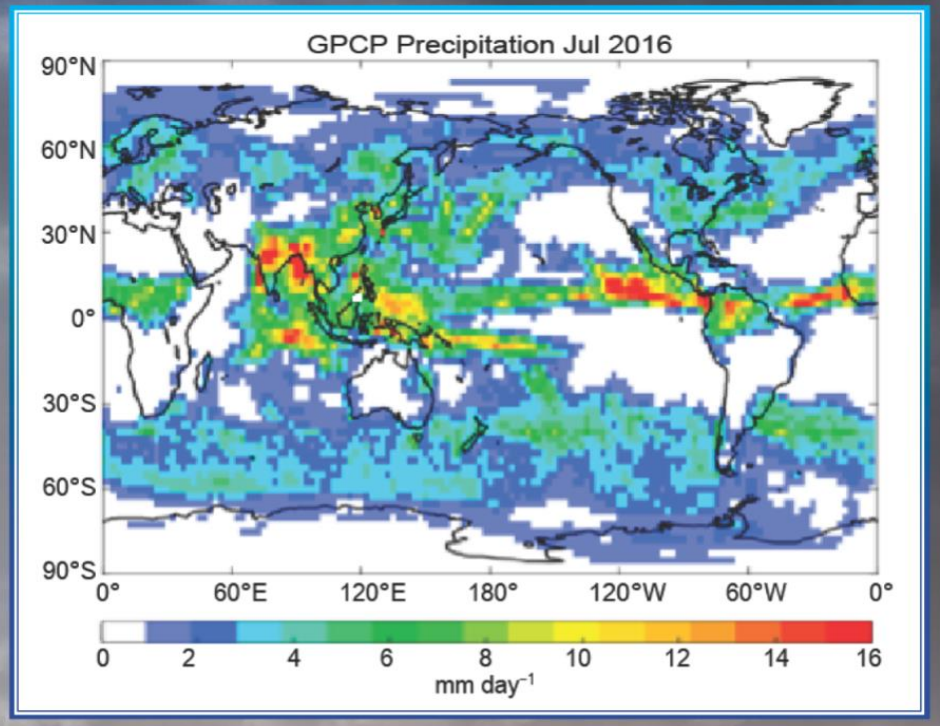
Level 3 (Mapped - Geophysical Variable)
Sfc Ref., NDVI, LAI, MLT, OHC, PERSIANN, Polar Pathfinder, Sea Ice Conc., Snow Cover

Level 3F (Mapped - Geophysical Variable - Spatially Complete)
OLR Daily/Monthly, CMORPH, GPCP, OISST

Level 3T (Mapped - Geophysical Variable - Temporal Stats)
ISCCP H, AOT, GPCP Daily/Monthly

Level 4 (Global Statistics)
TSI, SSI

Precipitation - GPCP Monthly



Climate Data Record Specifications

- Global coverage
- 2.5 × 2.5 degree product resolution
- 1979–present
- Global coverage
- Preliminary data updated monthly
- Final data updated every 3 months

Variables to this Climate Data Record

- Surface precipitation rate

Some Uses of this Climate Data Record

- Documenting precipitation climatology
- Studying seasonal cycle of precipitation
- Characterizing the evolution of global precipitation
- Validating climate model simulations
- Identifying climate extremes
- Validating other observations

Precipitation - GPCP Monthly:

https://www.ncdc.noaa.gov/cdr/atmospheric/precipitation-gpcp-monthly

Sample Atmosphere CDR Page

Optional User Registration

Product Details

Principal Investigator

Robert Adler, University of MD

Citation

Cite dataset when used as a source. See the dataset's landing page for citation details at doi:10.7289/V56971M6.

Data Access

- Download
- THREDDS
- Google (Cloud)
- Amazon (Cloud)

Information

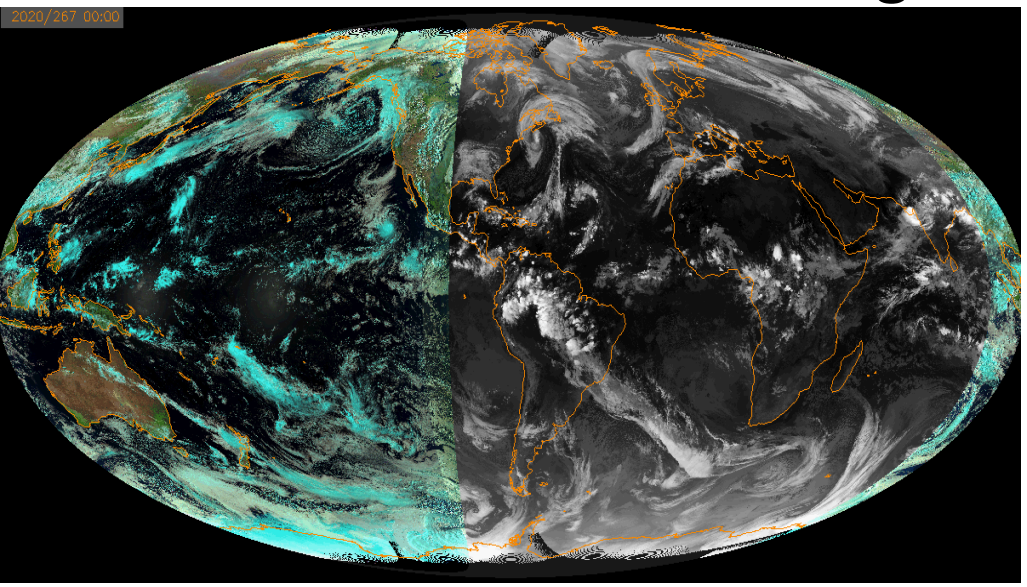
- Contact

Documentation

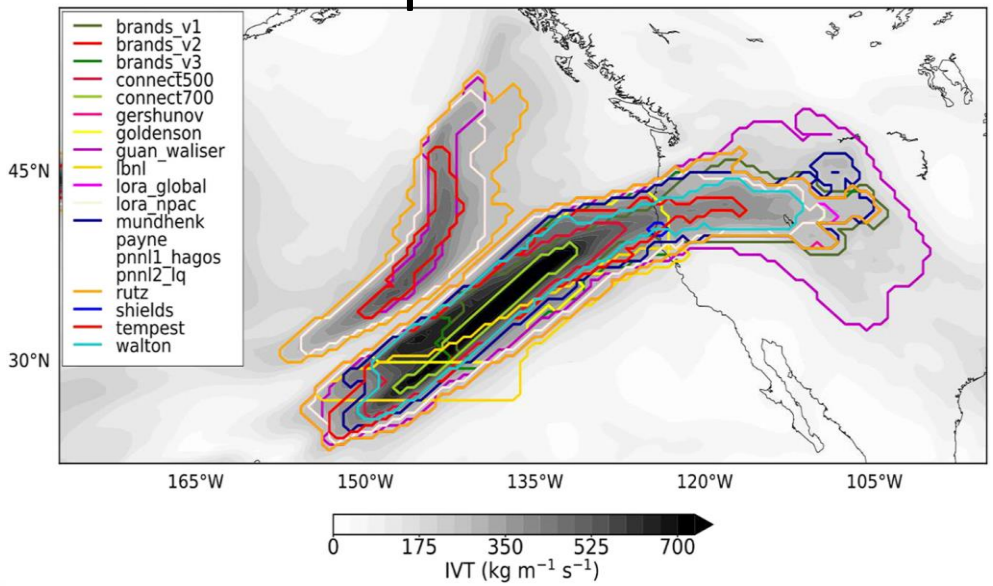
- CDR Flyer
- Use Agreement
- Algorithm Description
- Data Flow Diagram
- Maturity Matrix
- Source Code
- Technical Note

New CDRs are in the plans …

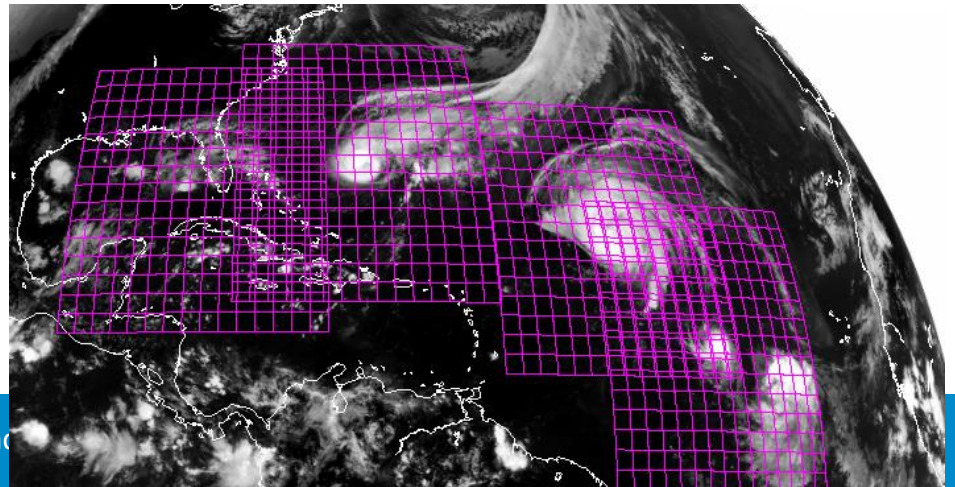
GOES FCDR & the GeoRing



Atmospheric Rivers



ADT-HURSAT



… and more

NOAA CDRs: a second life for operational satellite data

All CDRs provided in netCDF4

All CDRs are available on the cloud (AWS *et al.*)

16 primary ECV variables updated routinely *(but 100s more available)*

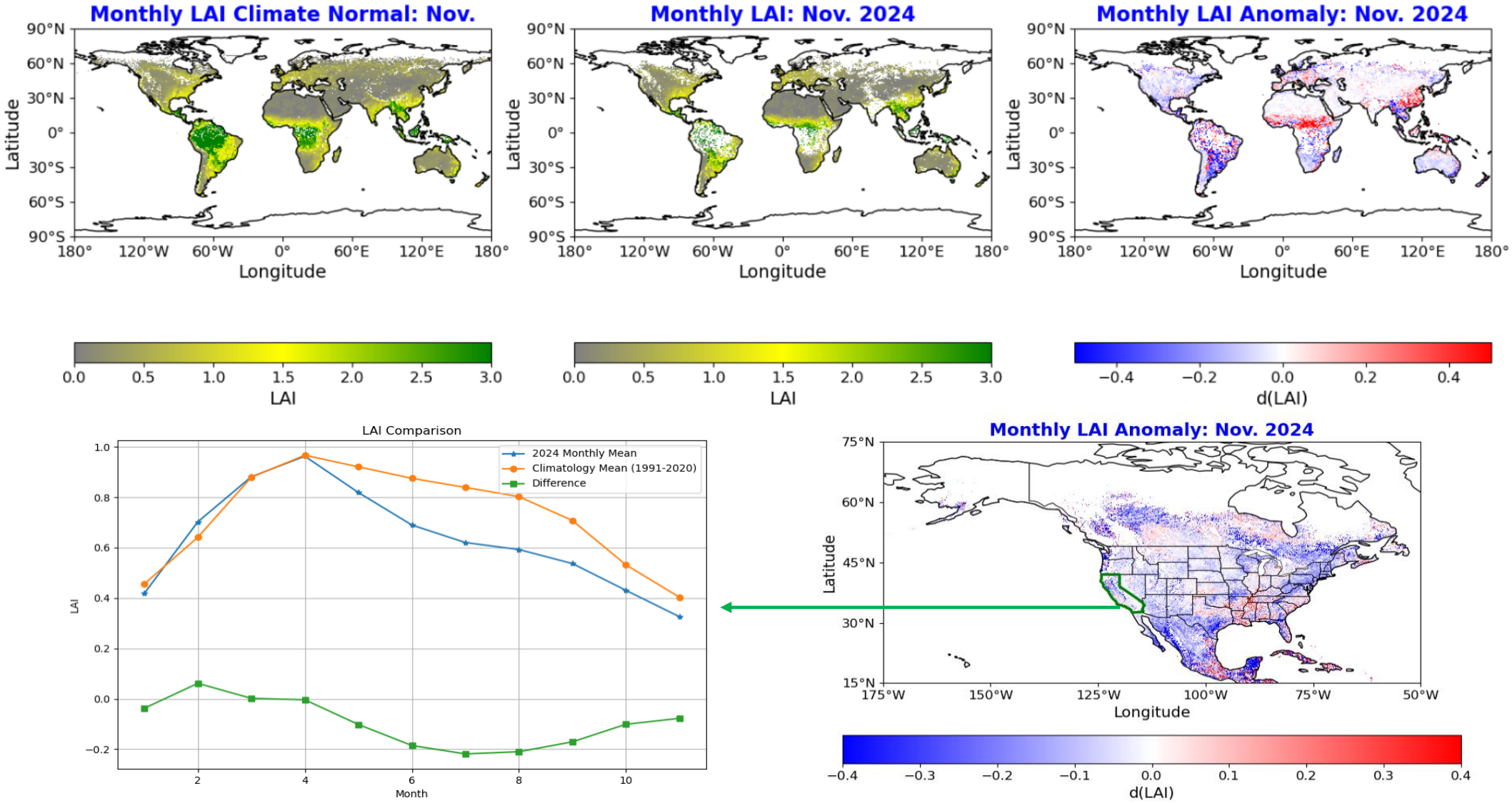
Sustaining production with newer satellites (JPSS, GOES-R, …)

Collaboration of NCEI with other NOAA offices, NASA, and academia

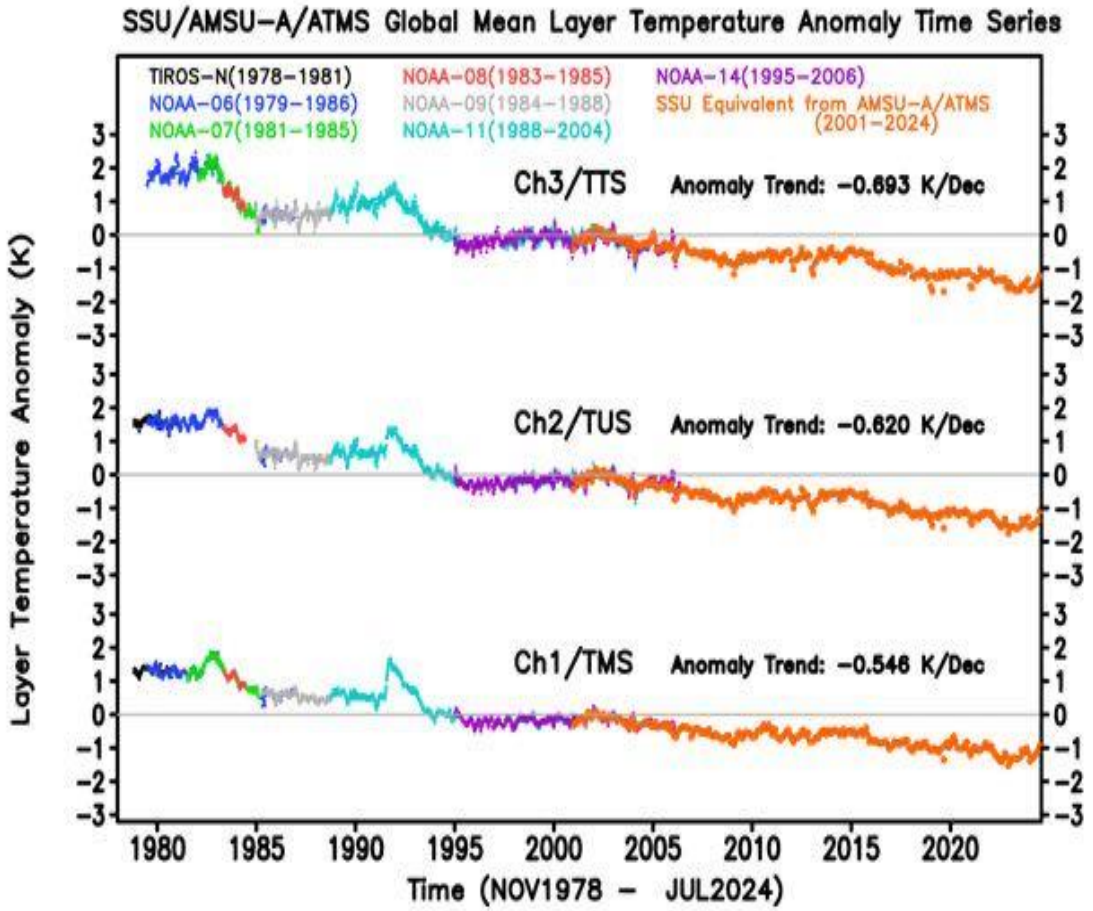
Collecting requirements to meet stakeholder needs

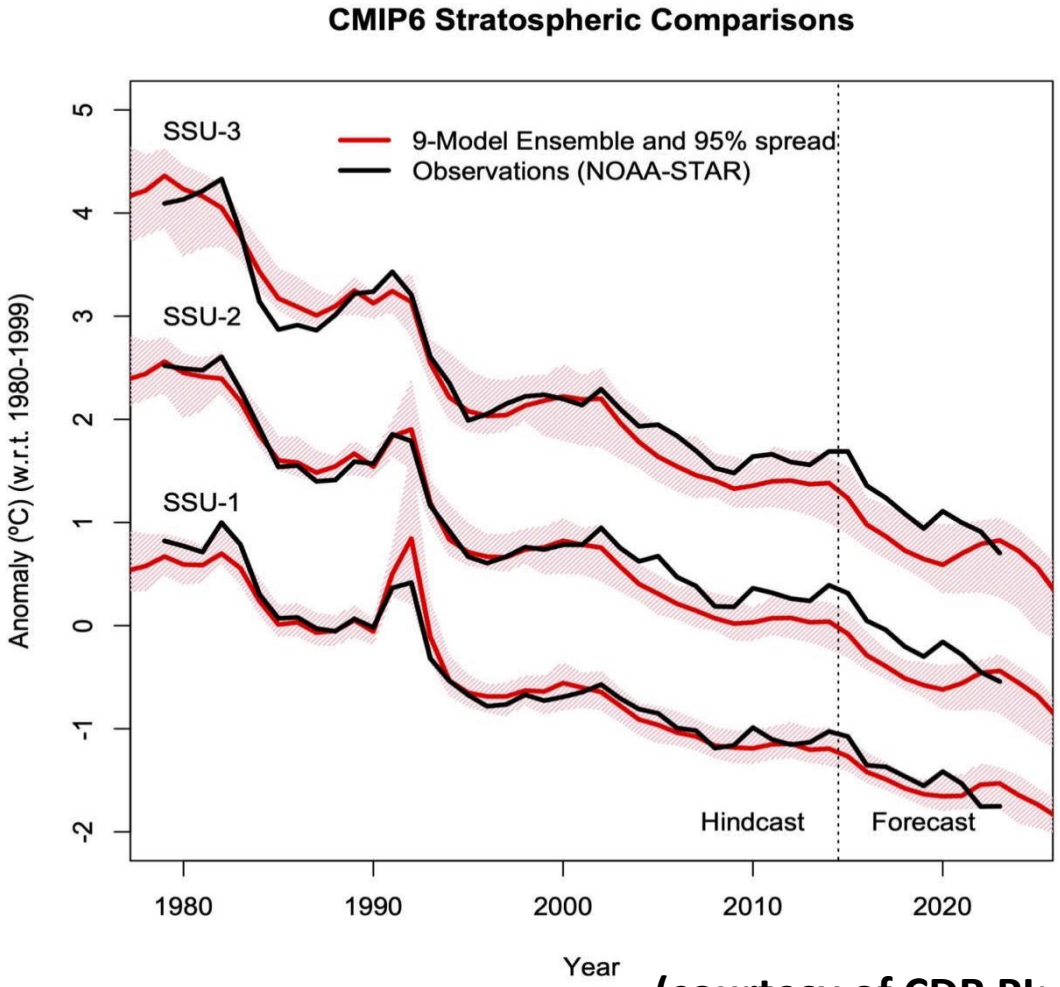
Examples of CDR Application

Monitoring Leaf Growth and Change



Trend Detection & Model Validation - Temperature

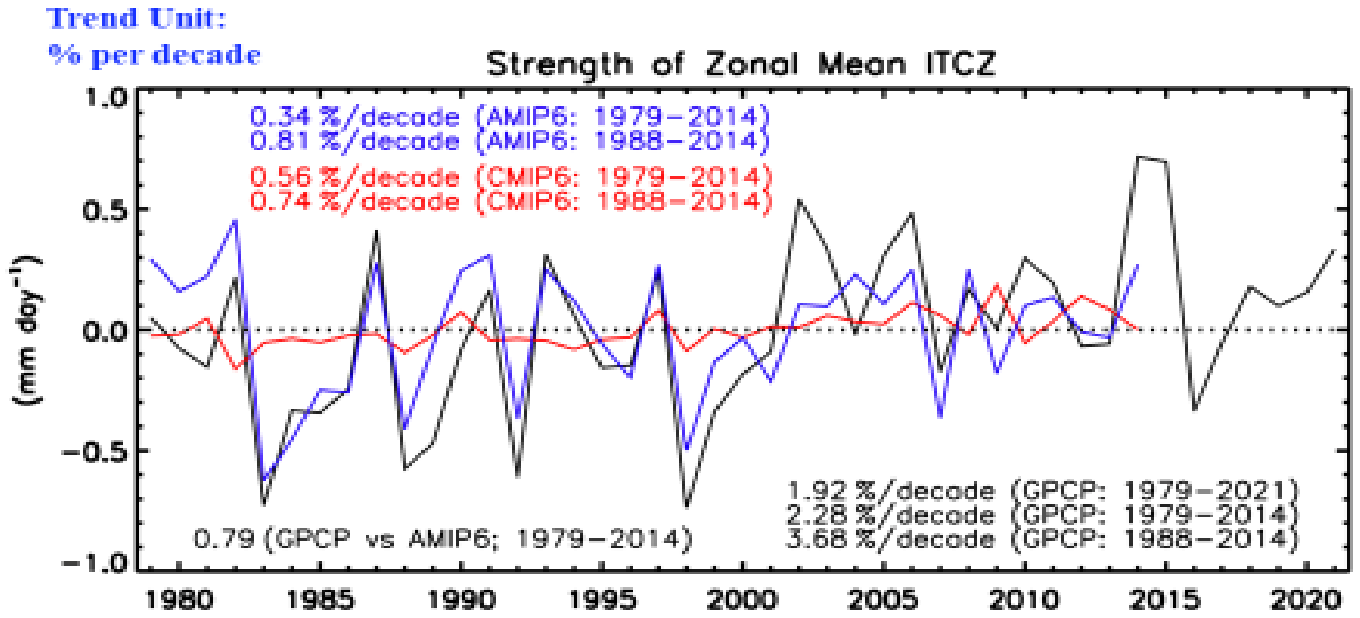




(courtesy of CDR PI: C. Zou)

Trend Detection & Model Validation - Precipitation

(Changes in the ITCZ Intensity Defined by Precipitation)



- The ITCZ is determined by zonal-mean monthly precipitation;
- The ITCZ strength is defined as the precipitation rate at the center latitude of the ITCZ

Global ITCZ intensity change rates (%/K) with global mean temperature change during 1979-2014.

	ITCZ Intensity	P_{95th}-P_m	P_m
GPCP	13.8	14.9	4.3
AMIP6	2.3	5.6	1.2
CMIP6-hist	2.4	2.5	0.6

- The zonal-mean ITCZ intensity has increased during the period with a comparable change rate as precipitation over tropical wet cells, both stronger than tropical mean precipitation increase;
- Model results tend to confirm the observed ITCZ change/trend, though the magnitude of change is smaller;
- AMIP6 further shows similar interannual variability in ITCZ intensity as GPCP;
- *These changes corroborate the strengthening contrast between wet and dry in the tropics.*

(courtesy of CDR PIs: B. Adler & G. Gu)

Challenges

❑ Technique

- How to extend CDRs seamlessly from heritage satellite measurement to new satellite measurement?
- How to derive climate information records (CIRs) from synergizing CDRs, in-situ observation, and model data to better support decision makers & users community?

❑ Resource

- Need stable budget to sustain and extend the operational CDRs. New funding is also needed for developing CIRs and new CDRs along with user engagement and service.
- Since CDRs are the 2nd life of operational satellite data, may be CDRs can be included in NESDIS satellite programs?

Summary

- NOAA Long-term satellite CDRs is the second life of NOAA operational satellite observational data.
- Systematic methodology and procedures have been developed at NCEI for the CDR development, production, archival, dissemination, and service.
- NOAA CDR products are very useful for environment and climate changing study and monitoring.
- We also face a resource challenge for sustaining and extending the operational CDRs as well as supporting CIRs and new CDRs development, applications, and users engagement.
- NESDIS satellite programs may help by including CDRs.

Acknowledgement

- **PIs of CDR development and production and personnel of CDR management, archival, dissemination, and service in the National Centers for Environmental Information (NCEI) of NOAA/NESDIS.**
- **Funding support from the NOAA CDR program before 2016 and limited budget support from the NCEI base fund after 2016.**

---Thank You for Your Attention---

Questions?

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