NOAA's Science Data Stewardship Project:

Background, Concepts, and Examples of Climate Data and Information Records (CDRs and CIRs)

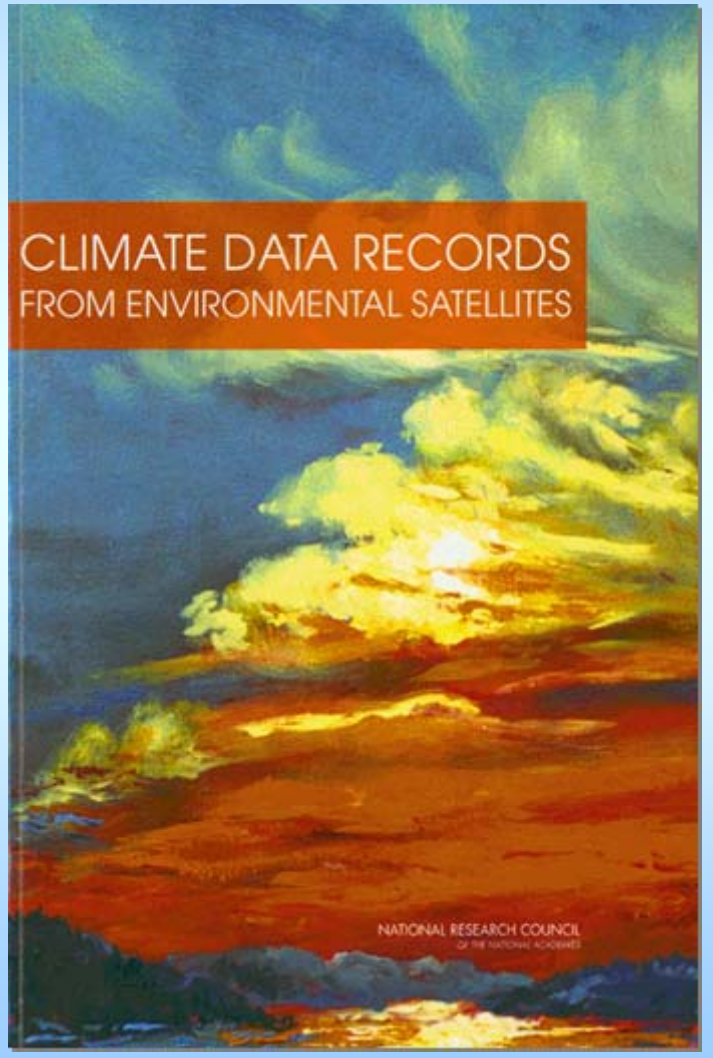
National Climatic Data Center (NCDC)

Asheville, NC

Scientific Data Stewardship Towards Systematic CDRs and CIRs

- NOAA's new Climate Change Science Program mandate is fundamentally different from its traditional weather forecasting mandate and raises a new set of challenges due to the varied uses of climate data, the complexities of data generation, and the difficulties in sustaining the program indefinitely.

- In response to this and the planned observatory transition from NASA research climate observing missions (*e.g.*, EOS, NPP) to operational missions (*e.g.*, NPOESS), the Scientific Data Stewardship Project was initiated to begin the systematic and sustained production of climate data and climate information records (CDRs and CIRs).



Working Definitions

1) A Climate Data Record (CDR) is a time series of measurements of sufficient length, consistency, and continuity to determine climate variability and change [NRC, 2004]. CDRs typically use data from different satellites and sensors extending from present back to the beginning of the relevant satellite observation period. For the NPOESS Climate Capability Restoration objectives, CDRs satisfy three additional characteristics:

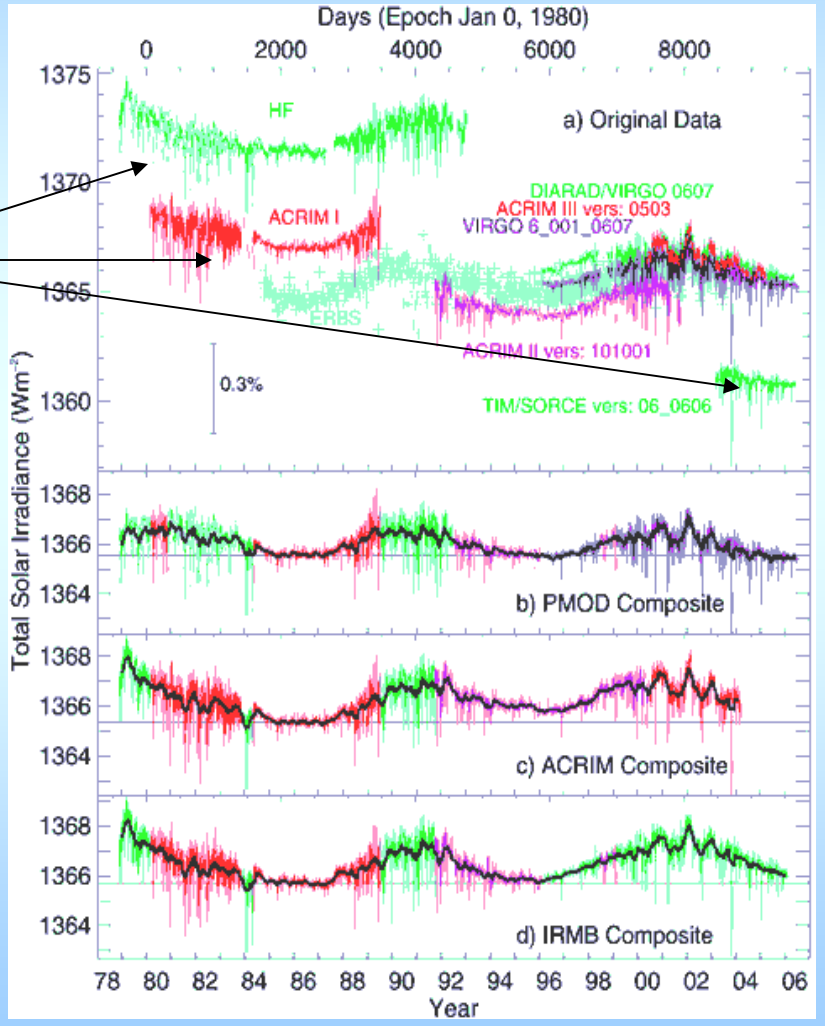
- CDRs are approved and prioritized by the CDR Working Group, composed of climate science leaders representing government, academia and industry; Group reviews of the CDR every 3-5 years to ensure it meets objectives and remains a priority or should be adjusted or sunsetted.
- CDRs' geophysical retrieval algorithms, underlying theoretical bases, and heritage products are mature, validated and proven useful in downstream research and applications.
- A CDR wholly or partially satisfies provision of a CCSP Earth Climate System Observation or a GCOS Essential Climate Variable, acknowledging that these consensus lists will change with time.

2) A Climate Information Product is a time series derived from CDRs and related long-term measurements to provide specific information about an environmental phenomena of particular importance to science and society. CIRs are often designed to convey key aspects of complex environmental phenomena in a manner useful to a variety of applications of particular interest to various user communities.

- *Examples of NOAA CIRs*: ENSO indices, Arctic Ozone Hole Area and Magnitude, Drought Severity, Tropical and Extra-Tropical Storm Intensity, Migration of Snow Transition Zones, Degree Days, Monsoon Characteristics, etc.

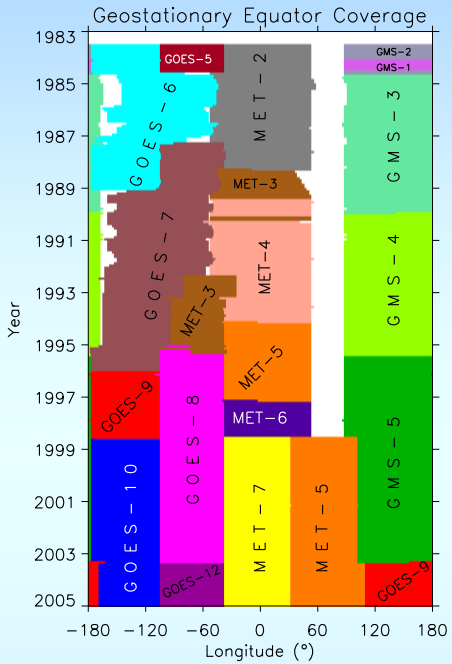
Example CDR: Solar Constant

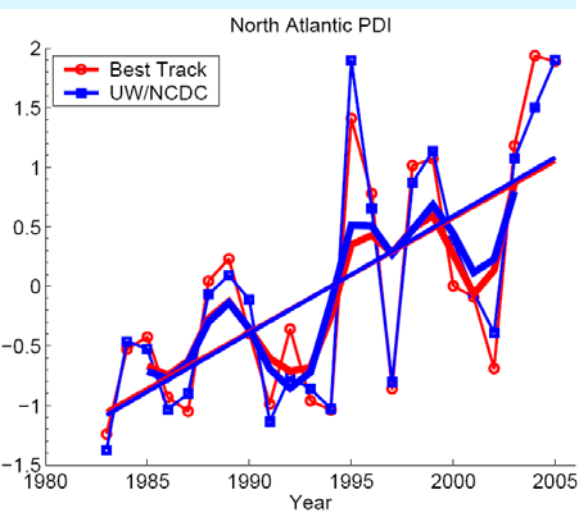
- Original data (EDRs) cover several decades
- Multiple data sources
- Work Needed for CDR:
  - Sensor models to explain differences
  - Development of homogeneous data set versions
  - Estimation of detectable variability and trends

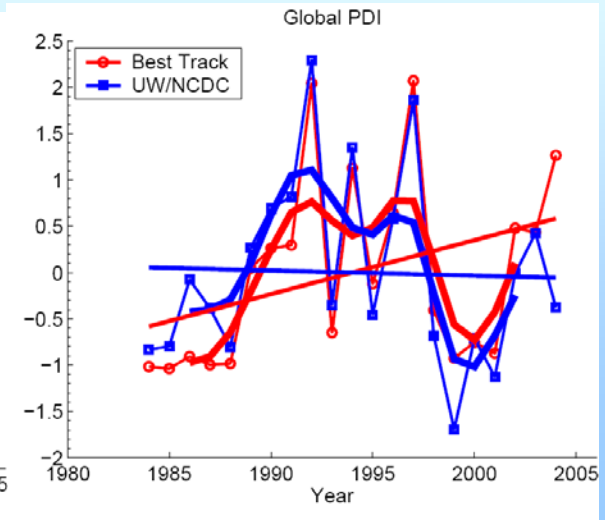


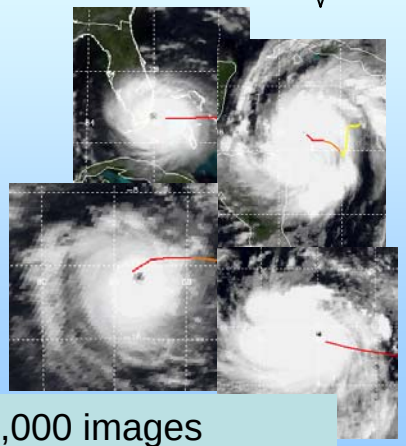
Example CIR: Hurricane Intensity

- Hurricane intensity historically estimated from “best track” data; different each year
- An objective reanalysis of homogeneous 23-year satellite data set was developed by NCDC
- U. Wisconsin developed an objective analysis algorithm to work with NCDC data.
- “UW/NCDC” intensities estimates allow NOAA to better identify trends in hurricane frequency and intensity









~169,000 images
~2,000 tropical cyclones

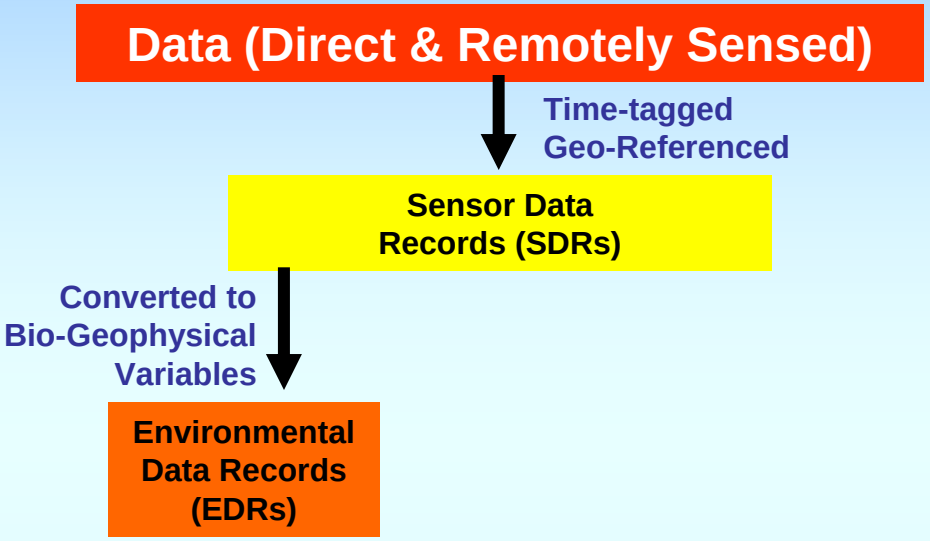
Notional Satellite Product Suite

Product	Example User Community	Production Approach	Accuracy and Completeness*	Latency* (Typical)
SDR/EDR	Weather and Hazards	Fast algorithms with unimproved observations and other inputs as available; no reprocessing	Average—speed outweighs accuracy; prior calibration information only	Near real time
Ongoing FCDR/TCDR	Monthly to inter-seasonal perspectives	"Frozen" xCDR algorithms applied to initially improved observations/auxiliary/ ancillary data; no reprocessing	Better— Fewer spatial or temporal gaps, initial sensor corrections and some post-observation calibration	1-2 weeks after observation
NOAA-Certified FCDR/TCDR	Long-term trend analysis and prediction	Latest/best xCDR algorithms applied to best quality inputs; reprocessed, multiple releases (updates)	Best— Fewest spatial or temporal gaps possible, best available (post-observational) sensor and orbit corrections	Months to Years

* Specifications are notional and approximate for qualitative comparison only.

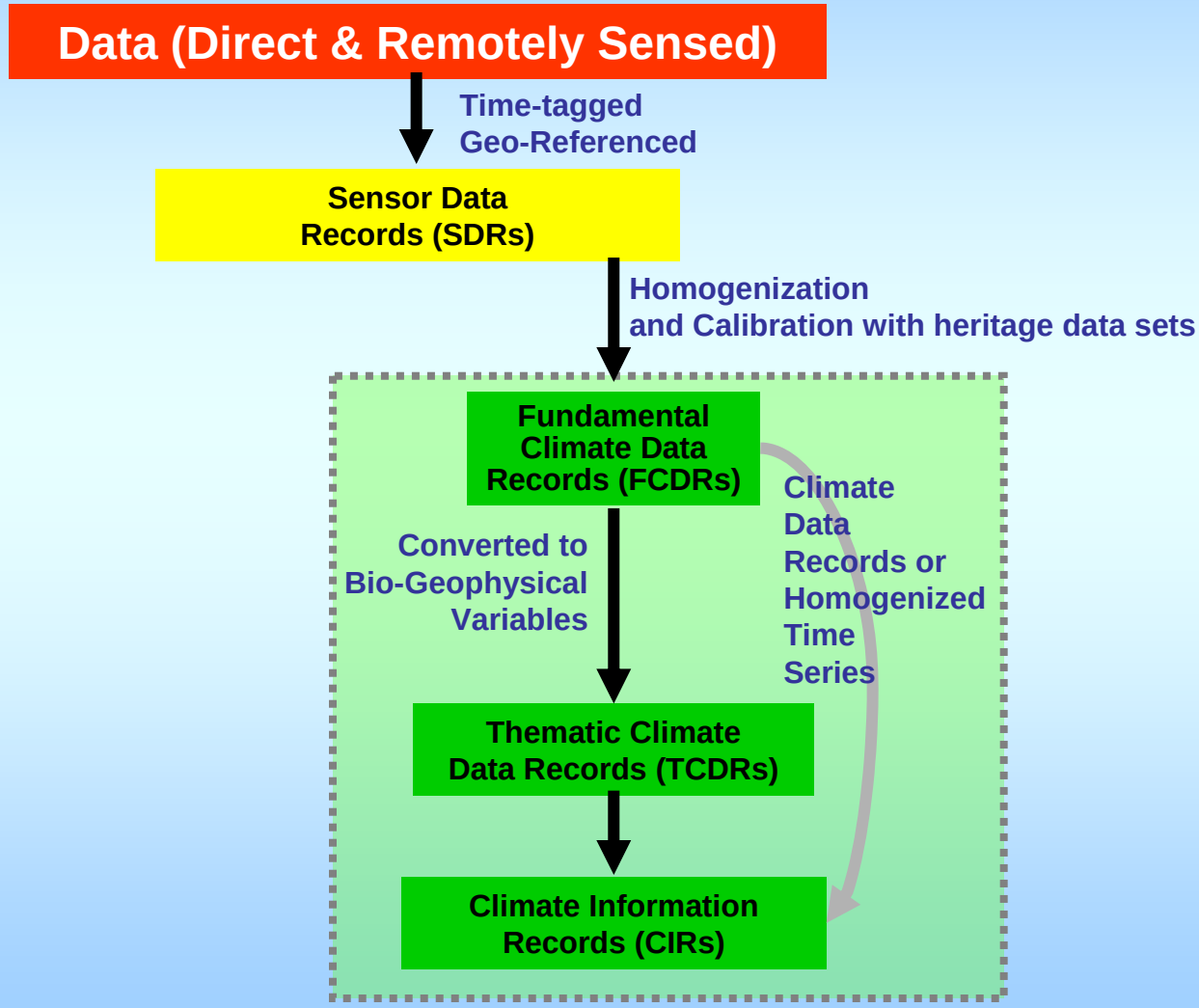
Weather vs. Climate Processing

Operational/Weather Data Records



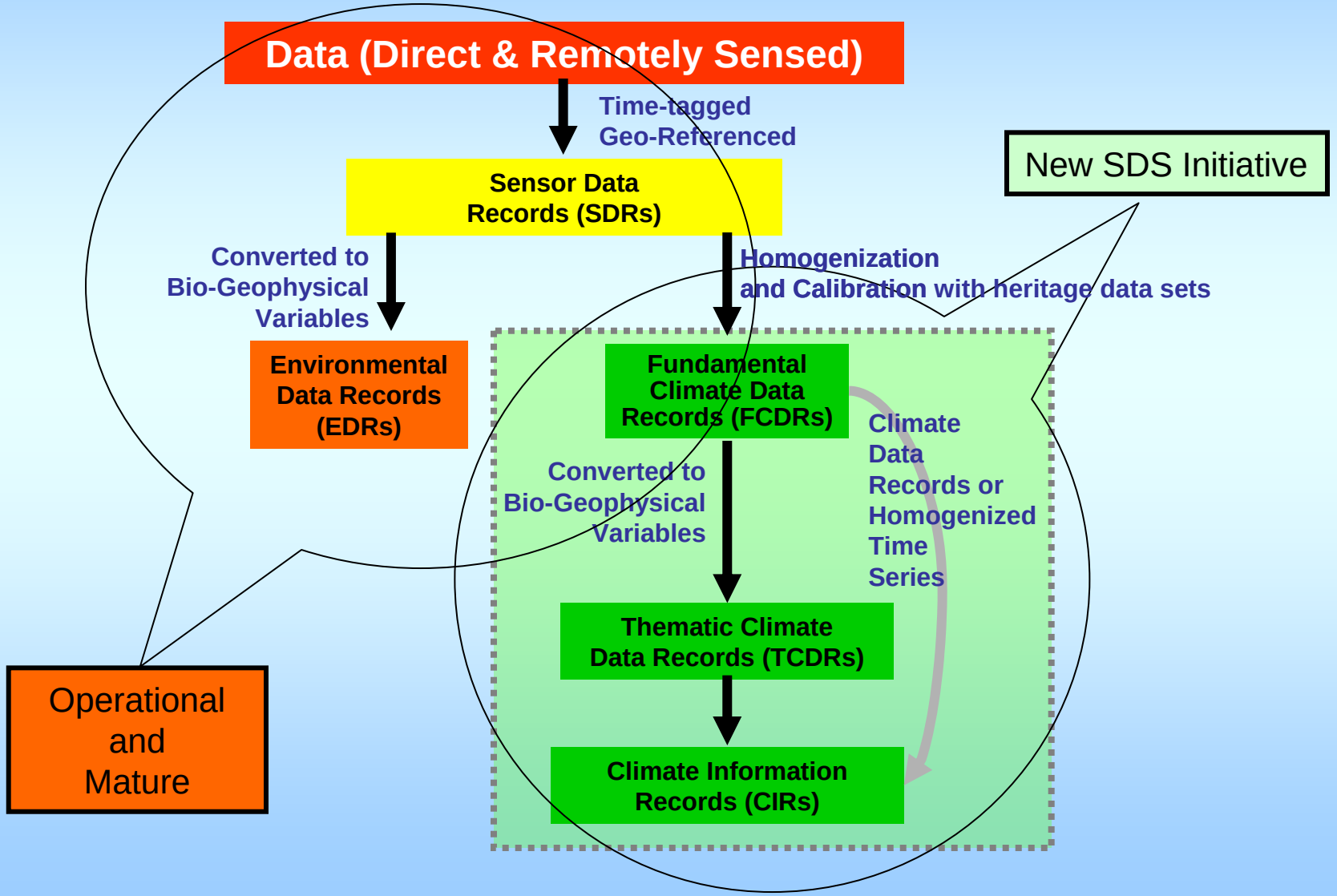
Weather vs. Climate Processing

Climate Data Records



Weather vs. Climate Processing

Distinct Paths, Technologies, and Timelines

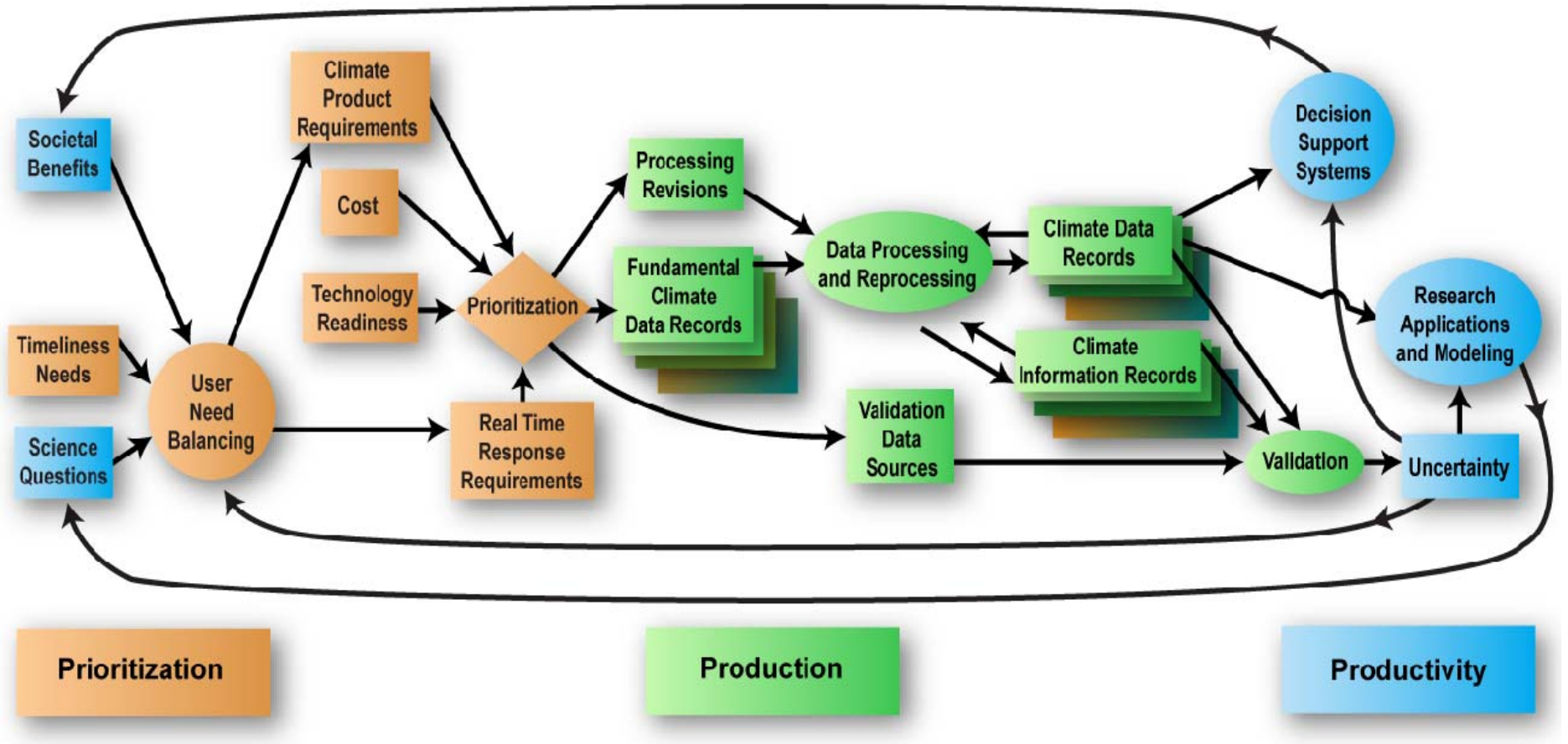


NOAA's Approach to Climate Products

1. **Balance societal benefits, climate science questions, data quality, and timeliness in prioritizing data processing and reprocessing**
2. **Develop systematic approach to improving data quality**
    a. Base error estimates on statistical and structural errors
    b. Ensure systematic and open validation, combining satellite data with in-situ measurements
3. **Systematically provide feedback on data access and use**
    a. Identify user communities and data use habits
    b. Quantify data user activities and adapt data products to user needs
    c. Feedback experience with data use into prioritization

CDRs and CIRs become a systematic and continual process for both research and operational satellite sensors.

NOAA Addressing Climate With End-to-End Framework



Conclusions

- NOAA's SDS is leading a joint agency effort to systematically and coherently develop superior climate products from NPOESS and heritage data to address needs of decision-makers, society, industry, and science

12

Backup

Further Examples of CDRs and CIRs

Candidate Climate Information Records (CIRs) from NPOESS

Climate Information Record (CIR)

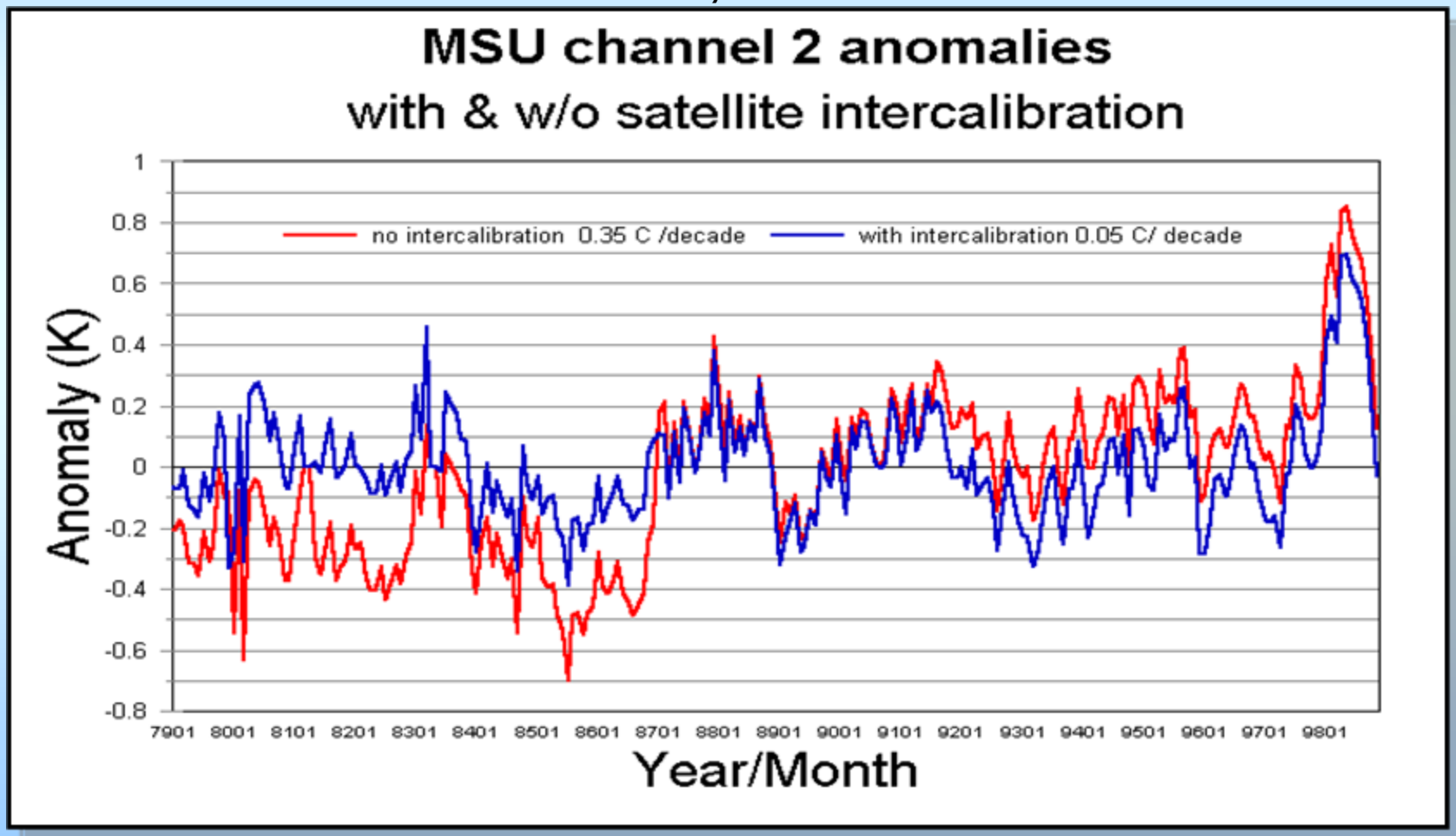
A Climate Information Product is a time series derived from CDRs and related long-term measurements to provide specific information about environmental phenomena of particular importance to science and society. CIRs are often designed to convey key aspects of complex environmental phenomena in a manner useful to a variety of user communities.

Discipline Area	CIRs (list names)	Primary Sensor Dependencies
Atmosphere	Climate Forecast System	VIIRS, CrIMMS, MIS
	Climate Data Assimilation System (CDAS) / Reanalysis	VIIRS, CrIMMS, MIS
	Ozone Hole Area	OMPS, CrIMMS
	Earth Radiation Budget	ERBS
	Stratospheric Warming	CrIMMS
	Extratropical Storm Tracks	CrIMMS
	Tropical Storm tracks	VIIRS, CrIMMS, MIS
	Teleconnection Indices	CrIMMS
	Multi-Decadal Signal	VIIRS, CrIMMS, MIS
	Tropical Atlantic Circulation Indices	VIIRS, CrIMMS, MIS
	Accumulated Cyclone Energy Index	VIIRS, CrIMMS, MIS
	North Atlantic Oscillation Index	CrIMMS
	Precipitation	MIS
	Ozone Hole Size	OMPS, CrIMMS
	Polarward Heat Flux	CrIMMS
	Polar Vortex Area	CrIMMS
	Polar Stratospheric Cloud Area	CrIMMS
	Cross Tropopause Mass Flux	OMPS, CrIMMS
	Stratosphere Temperature Monitoring	CrIMMS
	Total and Profile Ozone Monitoring	OMPS, CrIMMS
	SW/LW Radiation (evaporation)	CrIMMS
Ocean	ENSO Indices	VIIRS, CrIMMS, MIS
	Ocean Data Assimilation System	VIIRS, CrIMMS, MIS
	Surface Wind	MIS
	Surface Heat Flux	VIIRS, CrIMMS, MIS
	Salinity	MIS
	Sea Level Height	Altimetry
Terrestrial	Drought coverage/intensity	VIIRS, CrIMMS, MIS
	Flood monitoring	VIIRS, CrIMMS, MIS
	Snow Cover Area	VIIRS
	Soil Moisture	MIS

Only CDRs Provide the Accurate Rate of Global Warming

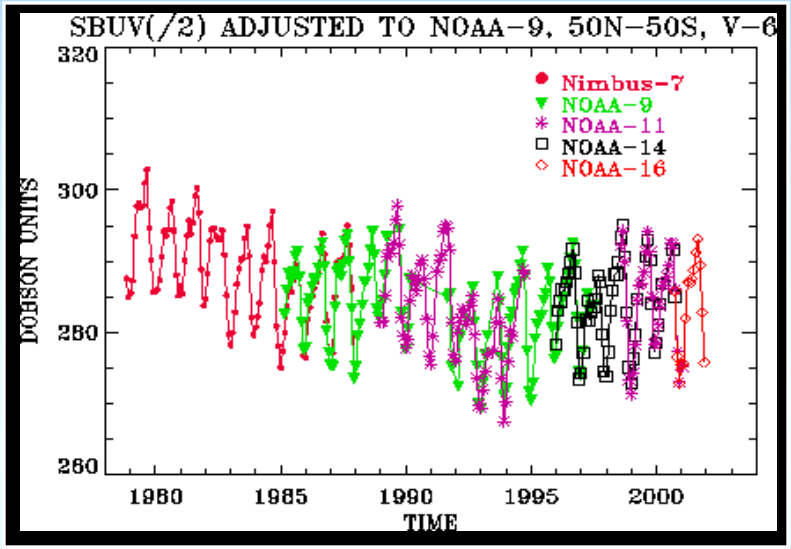
We require Intercalibrated CDRs in order to merge multiple, legacy observing systems

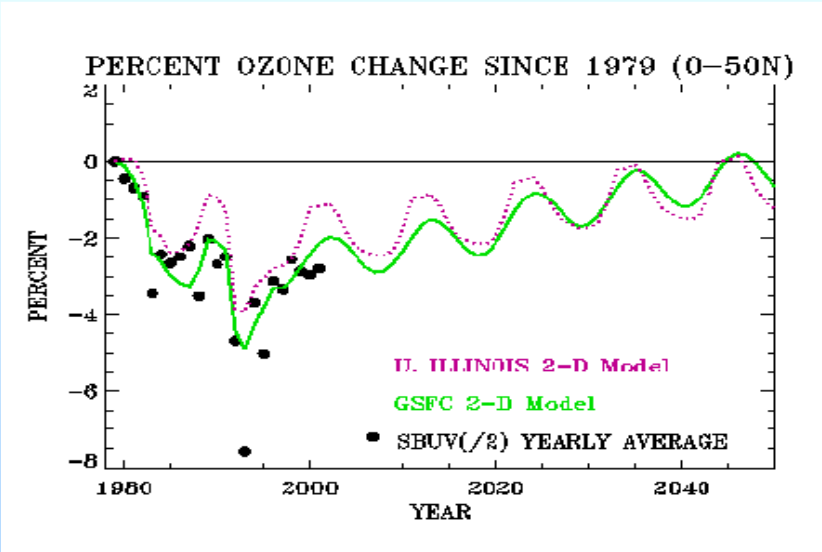
Red is EDR, Blue is CDR

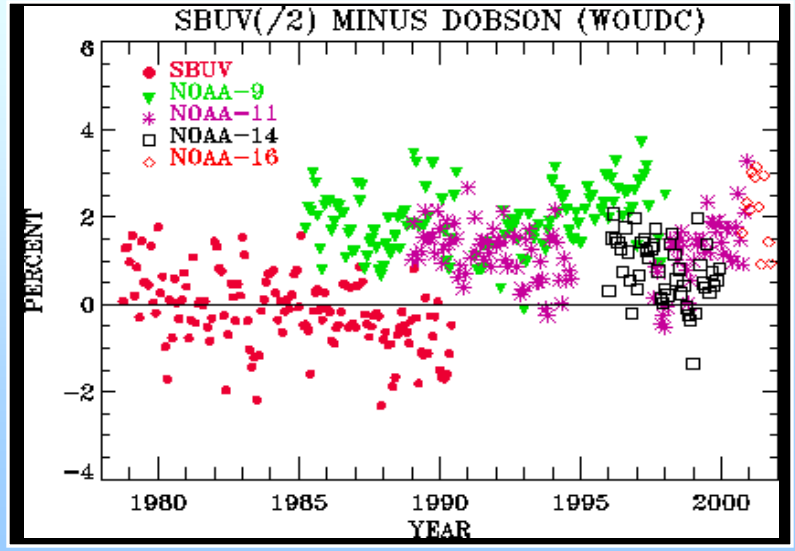


How do we Validate Models and Verify International Treaties? – Ozone Example

- Ozone is adjusted to NOAA-9
- Validated against Dobson Stations
- Reprocessed when new algorithms are developed by joint NOAA/NASA team
- Compared with models

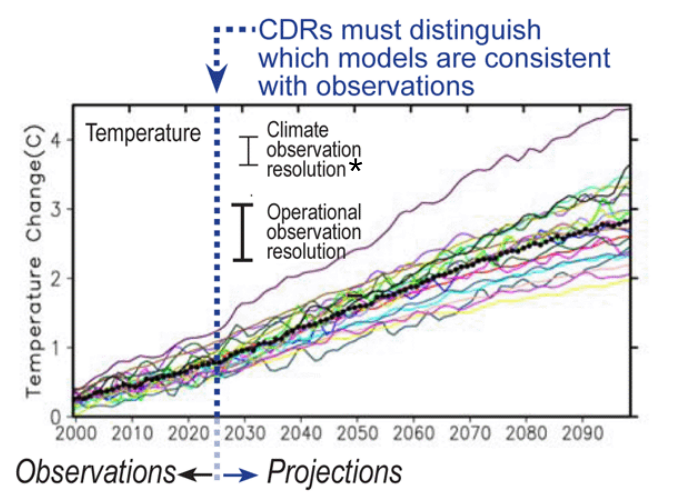


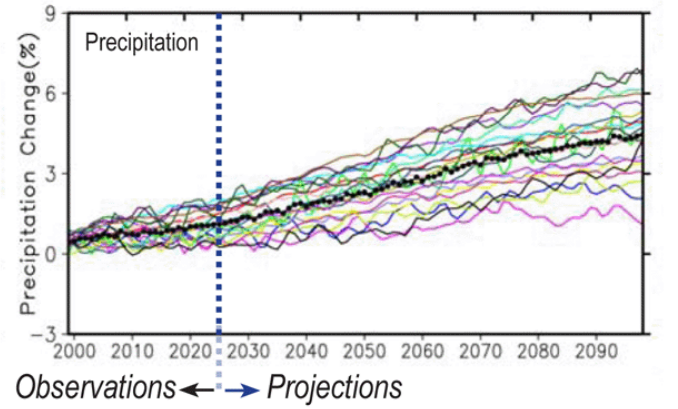


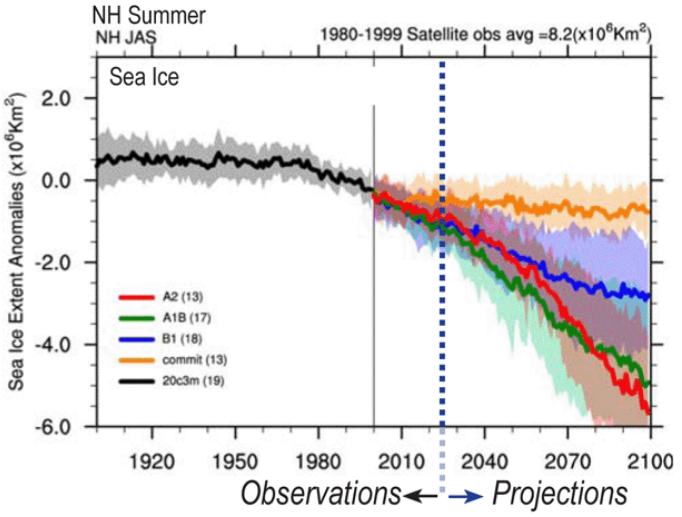


CDRs are Required to Validate IPCC

- IPCC model projections for temperature, precipitation, and sea ice vary greatly
- Mitigation and adaptation strategies depend critically on identifying which models are best
- Only high quality, sustained CDRs can validate climate model projections into the decades ahead







*Resolution scale in Panel 1 is notional only.

Estimated Potential of Source Data for Possible CDRs and CIRs (as of Fall 2007)