



# GOES Imager Fundamental Climate Data Record (FCDR)

## GSICS Annual Meeting VIS/NIR Breakout

**National Centers for  
Environmental Information (NCEI)**

March 2, 2023

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# Acknowledgements

Thanks to NESDIS (Mitch Goldberg), the GOES-R Program (Dan Lindsey), and the GEO-XO Program (Andy Heidinger) for supporting this work.



# Motivation

NOAA has the obligation to be a good steward of all GOES data.

The current approach to archive and access of historic GOES Imager data is not user-friendly:

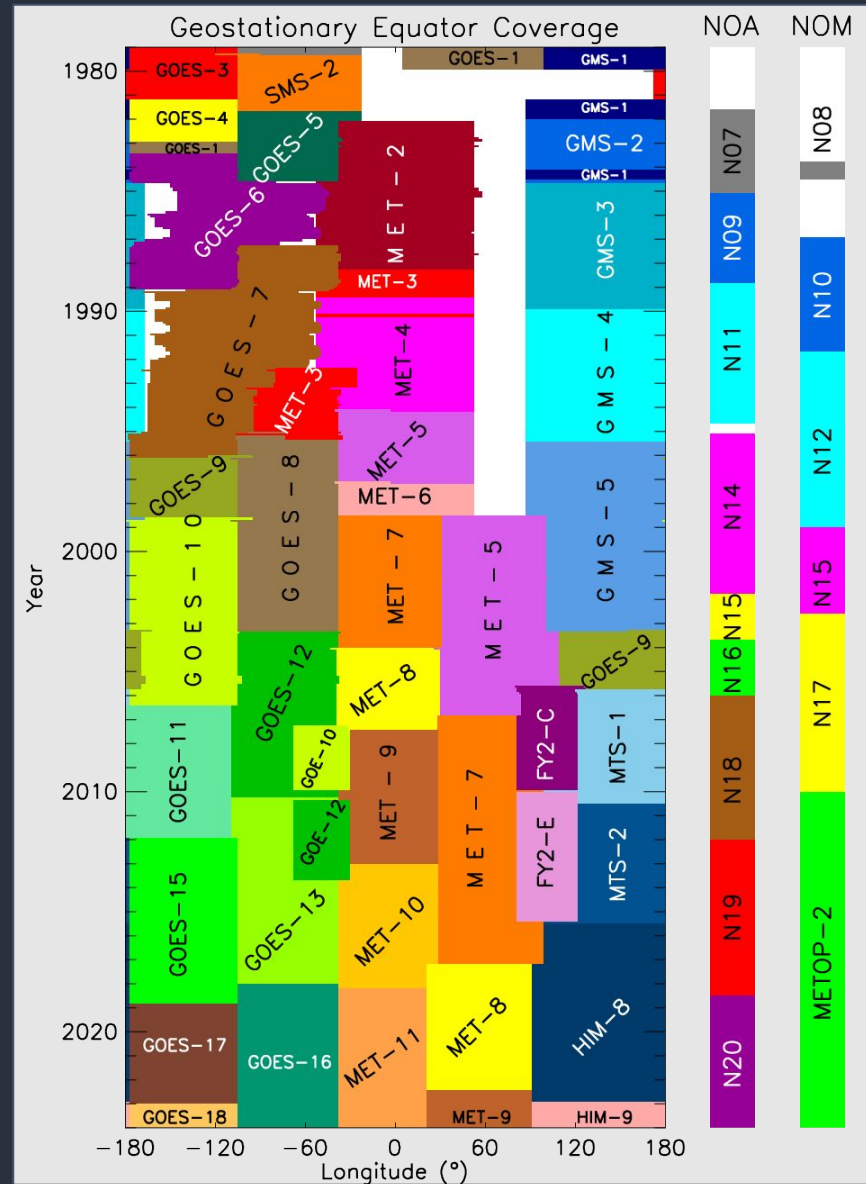
- ❑ archived data formats are difficult to use,
- ❑ there are known gaps in the time series,
- ❑ historical imagery has duplicates with no metadata explanation,
- ❑ calibration is not included, and
- ❑ the download process is arduous.

# Approach

This multi-year project will create a GOES Imager Fundamental Climate Data Record (FCDR) for all satellites from SMS-1 through GOES-15 (1974-2018). This static FCDR will be available operationally, while the original raw data will be moved to NCEI's deep archive. The GOES FCDR will provide data with:

- ❑ uniform format
- ❑ uniform data quality assessment
- ❑ uniform calibration
- ❑ uniform navigation

# Geostationary coverages



# Approach

Currently 3 projects underway:

- 1) Stewardship of SMS 1-2 and GOES 1-7 data (UW/SSEC)
- 2) Historical GOES 1-15 calibration (CISESS)
- 3) QC Tool development (EUMETSAT)



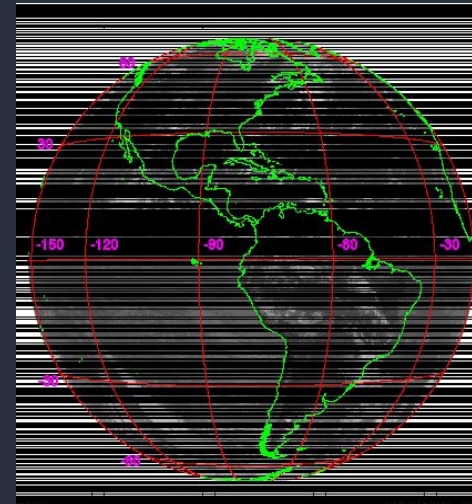
# Approach: SMS/GOES data rescue (1978-1996)

Stewardship of SMS 1-2 and GOES 1-7 data (UW/SSEC):

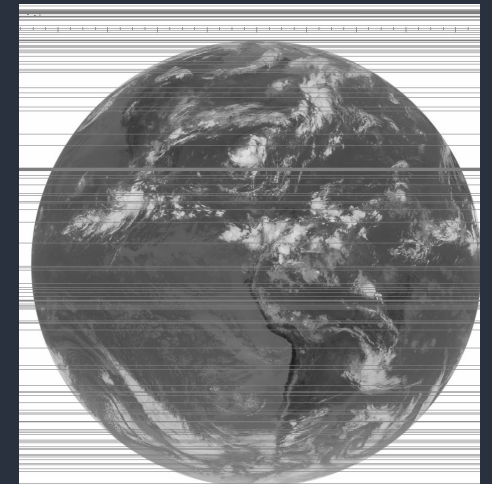
- ❑ The process for reading data from the tapes was not stable and resulted in incomplete files, multiple files, and corrupted files.
- ❑ Developed 'smart' decoders that detected errors in sync patterns (the binary data used to signal start of each scan from the satellite to the ground station). This results in restoring missing data to complete full disk images.
- ❑ Reconciliation of SSEC and NOAA/CLASS archive holdings
- ❑ Follow-on data rescue for GOES 8-15 planned for 2025.

# Approach: SMS/GOES data rescue (1978-1996)

- ❑ Lines deleted/added: Caused by multiple/bad sync or ground station send errors, sometimes resulted in multiple images in one index.
- ❑ Bit slip: Bits inserted between sync and type blocks and/or data, probably from when U-matic was first recorded, or may have happened during playback.
- ❑ Fixed type: IR (0) or VIS (1-8) incorrect, sometimes due to bit slip or multiple/bad sync.
- ❑ Fixed line number: Line number was changed, caused by bit error.
- ❑ Framing Error: IR data block size was incorrect.



NOAA CLASS  
GOES-5 IR 1981-08-17  
15:30 UTC



SSEC reprocessed  
GOES-5 IR 1981-08-17  
15:30 UTC



# Approach: SMS/GOES data rescue (1978-1996)

Progress so far:

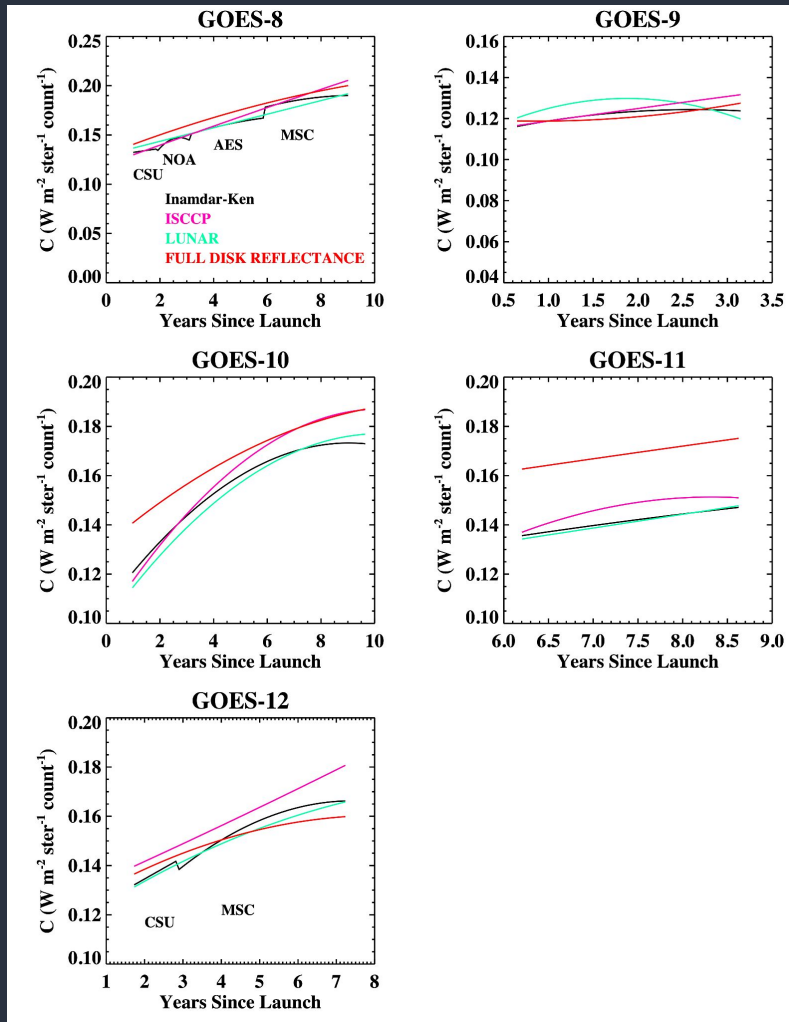
- ❑ ~2,800 Mode-A images thought to be completely lost were recovered. (~60 days)
- ❑ ~8,100 images had corrections to at least 95% of their image lines. (~170 days)
- ❑ ~25,500 images had framing errors corrected that affected every visible scan in an image. (~530 days)
- ❑ With removal of duplicate images, projected to reduce volume of GOES 1-7 archive from ~115 TB to ~70TB

# Approach: Historical GOES 1-15 calibration

## Project scope:

- ❑ Review and assess existing calibration approaches of historical GOES visible and infrared channels.
  - ❑ Perform new calibrations only as necessary.
  - ❑ Plan how to incorporate calibration information into the final CDR.
- ❑ Define GOES FCDR format: using GOES R format (metadata & variables) as template for and also comparing with EUMETSAT FCDR formats for consistency and compatibility.
- ❑ Prepare for and perform data processing (in the cloud).

# Approach: Historical GOES 1-15 calibration



## Methods evaluated thus far:

- ❑ *Inamdar-Ken*: Intercomparison of Independent Calibration Techniques Applied to the Visible Channel of the ISCCP B1 data (Inamdar and Knapp, 2015)
- ❑ *ISCCP*: Normalization and calibration of geostationary satellite radiances for ISCCP (Desormeaux et al, 1993)
- ❑ *Lunar*: Evaluation of ISCCP multisatellite radiance calibration for geostationary imager visible channels using the moon (Stone et al, 2013)
- ❑ *Full Disk Reflectance*: Using GOES-R ABI Full-Disk Reflectance as a calibration source for the GOES Imager channels (Heidinger et al, 2022)

# Approach: Historical GOES 1-15 calibration

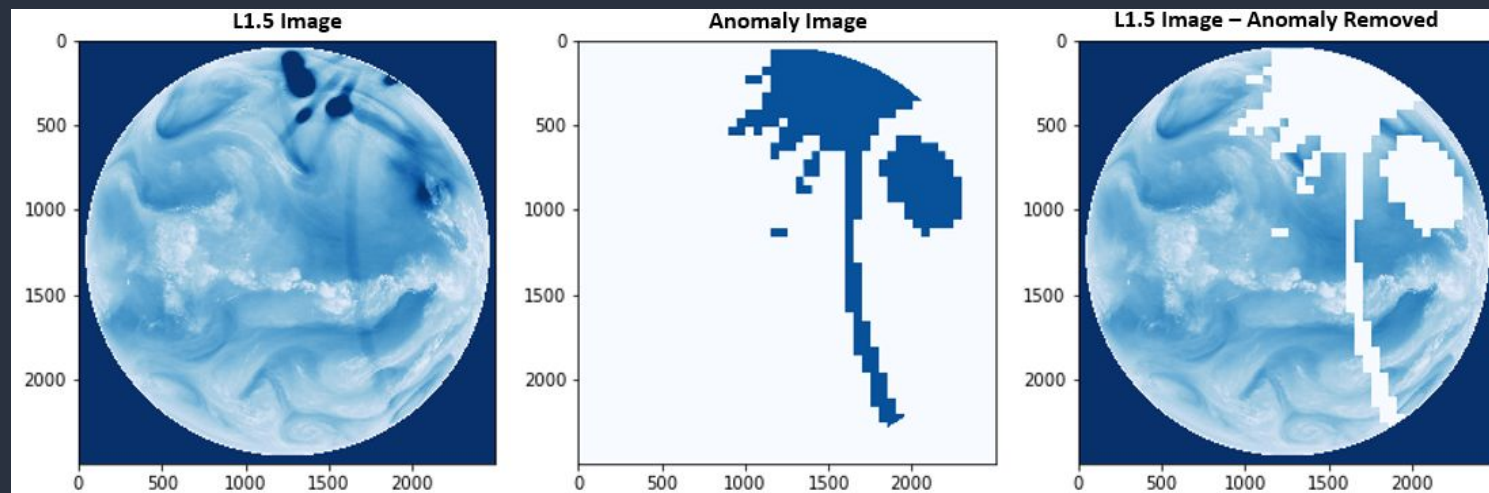
We are just starting, and looking to this group for advice! In particular:

- ❑ Any calibration information for VISSR (SMS 1-2) or VAS (GOES 1-7)?
- ❑ What additional existing corrections for GOES 8-15 should we consider?
  - ❑ *VIS*: Weinreb et al (1999), Crosby et al (2005), Wu et al (2005), Leisso et al (2007), Yu et al (2014/2015)
  - ❑ *NIR*: Weinreb et al (1999)
  - ❑ *IR*: Weinreb et al (1999)
  - ❑ *WV*: Weinreb et al (1999)
- ❑ What important aspects do we need to consider?
- ❑ Thoughts on how to incorporate calibration information into the final CDR?

# Approach: QC Tool Development

EUMETSAT is developing a QC tool that uses AI to identify scan artifacts in the GOES record, for global consistency, as has already been done for other international geostationary satellites (e.g. Meteosat, GMS).

NOAA will apply the QC tool (to be completed in 2023) during GOES FCDR reprocess.





# EUMETSAT-NOAA Geo-Ring FCDR Project

The major objective of this project (2023-2027) is to establish an infrastructure that enables the sustainable generation of a Fundamental Climate Data Record (FCDR) from the measurements of all sensors on-board geostationary satellites.

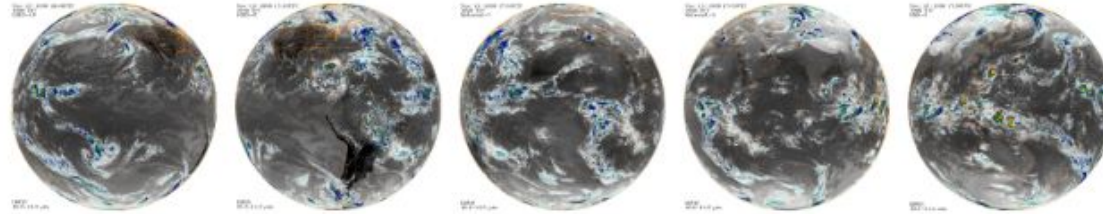
Approved at joint NOAA-EUMETSAT High Level Working Group in February 2023.

Participants: Joerg Schulz, Viju John, Roope Tervo (EUMETSAT)  
Ken Knapp, Jessica Matthews, Joseph Mani (NOAA)

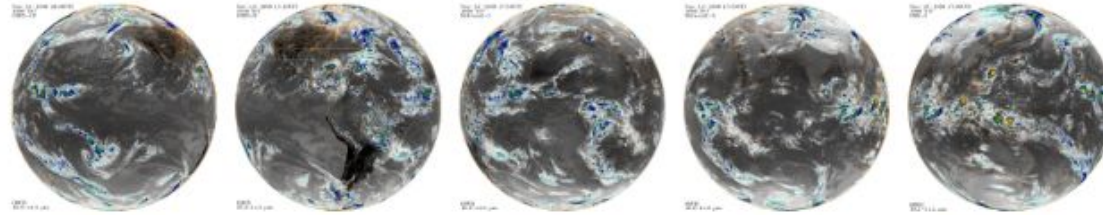


# EUMETSAT-NOAA Geo-Ring FCDR Project

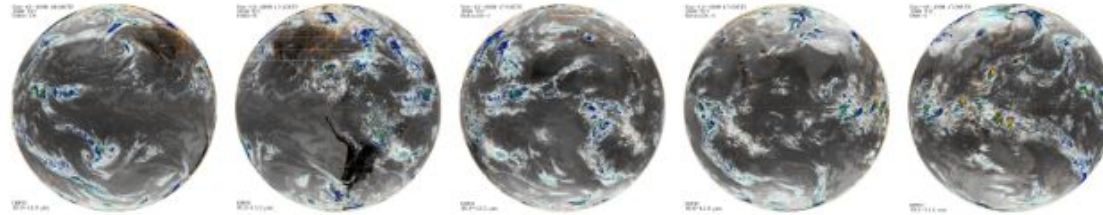
Raw Data



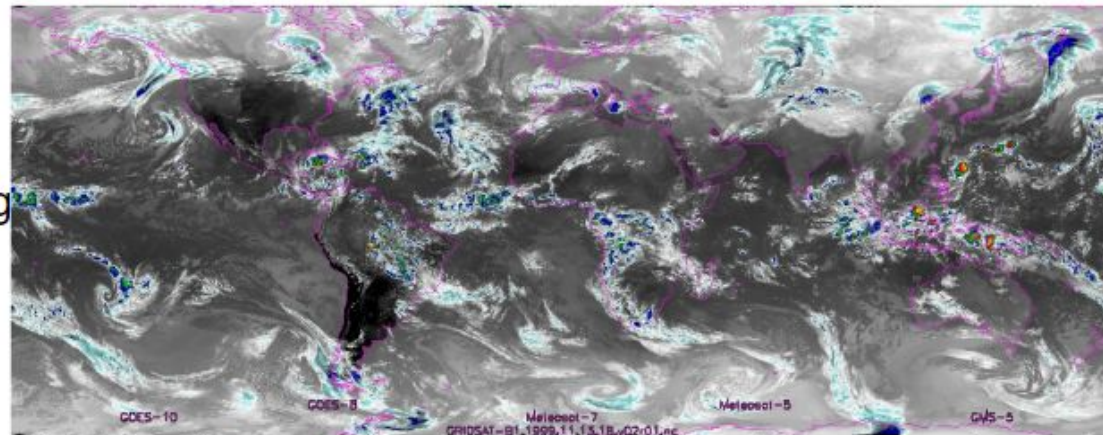
GEO FCDR



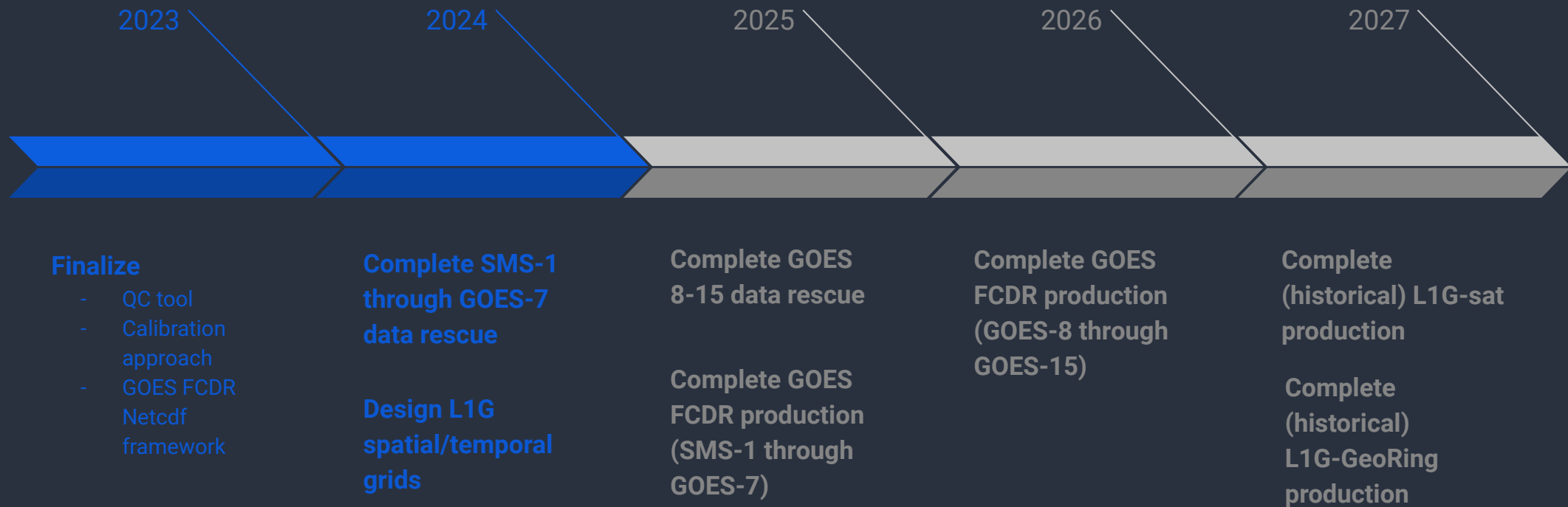
L1G-sat



L1G-GeoRing



# Timeline



# Conclusions

The GOES Imager Fundamental Climate Data Record (FCDR) for all satellites from SMS-1 through GOES-15 (1974-2018) will have:

- ❑ uniform format
- ❑ uniform data quality assessment
- ❑ uniform calibration
- ❑ uniform navigation

While a stand-alone product, it will also contribute to the larger EUMETSAT-NOAA Geo-Ring FCDR product.

