

# A Systematic Approach to CDR Inventory Assessment

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# What is the CEOS SEO?



- The **CEOS Systems Engineering Office (SEO)** was established in April 2007 (sponsored by NASA) to facilitate the development of CEOS global space plans.
- The SEO **technical functions** include: requirements definition, gap assessments, systems databases and tools, special projects, and system architecture development.
- The SEO **management functions** include: improving communications through web-based management tools (website, mailing lists, action tracking), and developing written and media products for CEOS education and outreach.

# SEO Support to the WGClimate



SEO is supporting the WGClimate actions outlined by the CEOS Chair to GCOS and the WCRP as follows:

1.) Undertake a review of the generation of FCDRs and derived ECV satellite products by Member Space Agencies

- Collected FCDR data from NASA, ESA, and SCOPE-CM and populated an online “inventory” database
- Next, plan to include NOAA data

2.) Identify multi-agency implementation teams for each product and review their actions

- Each CDR entry in the database provides a Principle Investigator and the lead Agency to help in the identification of suitable teams

# SEO Support to the WGClimate, cont' d



3.) Ensure the coordination of climate product generation with other relevant international initiatives

- Database will provide timelines for each ECV based measurement that give the CDR and the timeframe
- These timelines provide a quick assessment for potential international collaboration

# Database Concept for CDR Inventory



## **Preliminary ECV Inventory Data**

- CDR Project Names and Descriptions
- CDR Start and End Dates
- CDR Principle Investigator
- Limited to NASA Measures program, ESA CCI, and SCOPE-CM

## **Future ECV Inventory Data**

- Add other agency CDR project preliminary data
- Add additional information as WGClimate deems necessary
- CDR Maturity Index Factors, including information related to sensor use, algorithm stability, metadata and QA, documentation, validation, and public release

## **Systems Database Foundation**

- CDR Projects linked to an Agencies, ECVs, and MIM Instruments and Measurements

## **Current Limitations**

- Instrument-measurement errors in the underlying MIM database prevent some linkages

## **Current Limited Query Ability Needs to Expand**

- ECV Timeline showing CDR projects and various gaps
- CDR Inventory page with project descriptions

# Screenshots of CDR Database



- **Climate Tab currently limited to showing all the CDR projects**
- **Could add queries by ECV, agency, instrument, measurement product, and mission**

Primary Investigator	Agency	Project	Description	ECV	Start	Stop	Missions	Instruments
Atlas, Robert	NASA	A Cross-Calibrated Multi-Platform Ocean Surface Wind Velocity Product for Meteorological and Oceanographic Applications	High resolution (25km, every 6-hours) global ocean surface winds from 1987 through 2012.	Surface Wind Speed and Direction	1987	2012	ADEOS-II Aqua DMSP F-10 DMSP F-11 DMSP F-12 DMSP F-13 DMSP F-14 DMSP F-15 DMSP F-8 QuikSCAT TRMM	SeaWinds AMSR-E SSM/I TMI
Chen, Gao	NASA	Creating a Unified Airborne Database for Assessment and Validation of Global Models of Atmospheric Compositions	Aircraft observations of trace gases and aerosol properties.	N/A	1985	2011	"N/A"	"N/A"
Chin, T. Mike	NASA	Multi-sensor Ultra-high Resolution Sea Surface Temperature	Daily Sea Surface Temperature at 1-km horizontal resolution	Sea Surface Temperature	1981	2011	Aqua Metop-A Metop-B Metop-C NOAA-15 NOAA-16 NOAA-17 NOAA-18 NOAA-19 Terra	AMSR-E AVHRR/3 MODIS
Didan, Kamel	NASA	VIP: Vegetation Phenology and	Global 5,600-m EVI2 and	Biomass	1981	2011	Aqua	AVHRR/3

# Screenshots of CDR Database



- CDR Project Queries are currently limited to timelines by ECV
- Could add timelines by measurement products, instruments, and missions

## ECV: Aerosol Properties - 5 Records Located

Gold-colored squares indicate CDR project coverage.

Project	Agency	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Twice Daily Fields	NOAA	Gold	Gold	Gold	Gold	Gold	Gold	Gold	Gold	Gold	Gold	Gold	Gold	Gold	Gold	Gold	Gold	Gold	Gold	Gold	Gold
Global Aerosol Optical Thickness	NASA	White	White	White	White	White	White	White	White	White	White	White	White	White	White	White	White	Gold	Gold	Gold	Gold
Global Aerosol Size	NASA	White	White	White	White	White	White	White	White	White	White	White	White	White	White	White	White	Gold	Gold	Gold	Gold
Aerosol Absorption	NASA	White	White	White	White	White	White	White	White	White	White	White	White	White	White	White	White	Gold	Gold	Gold	Gold
CCI Aerosols	ESA	White	White	White	White	White	White	White	White	White	White	White	White	White	White	White	White	Gold	Gold	White	White



# Screenshots of CDR Database



[www.ceos.org](http://www.ceos.org)



## Systems Database Description

The Committee on Earth Observation Satellites (CEOS) Systems Engineering Office (SEO) Systems Database is designed to support CEOS strategic planning and gap assessments. The content includes current and planned space-based CEOS missions from ESA's CEOS Database of Missions, Instruments and Measurements (MIM) along with additional links to CEOS Constellations, GEO Societal Benefit Areas (SBA) and GEO Essential Climate Variables (ECV). In order to adequately support gap assessments, the database also contains measurement requirements from a variety of sources. Resulting measurement and data continuity gaps will help identify potential collaborative opportunities for CEOS long-term strategic planning. The SEO envisions this tool will support the GEO Communities of Practice, CEOS Constellations, CEOS SIT leadership, and CEOS agencies.

## CDR Inventory Data

- PI, Agency, Project, Description, ECV, Start, Stop
- Mission and Instrument inputs

## ECV Measurement Timelines

- Measurement
- Years
- Links to Missions and Instruments



# CDR Database Built on a MIM Foundation: The CEOS Databases



[www.ceos.org](http://www.ceos.org)

Systems Database

[www.ceos-sysdb.org](http://www.ceos-sysdb.org)

MIM Database

[database.eohandbook.com](http://database.eohandbook.com)

ECV: Cloud Properties

Measurement	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Cloud base height	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Cloud cover	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Cloud ice (column/profile)	2	2	2	2	1	2	2	2	2	1	2	2	3	3	3	3	1	0	0	0
Cloud ice content (at cloud top)	5	5	5	5	0	0	0	1	1	2	2	2	3	3	3	3	2	2	1	1
Cloud liquid water (column/profile)	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	4	2	1	1

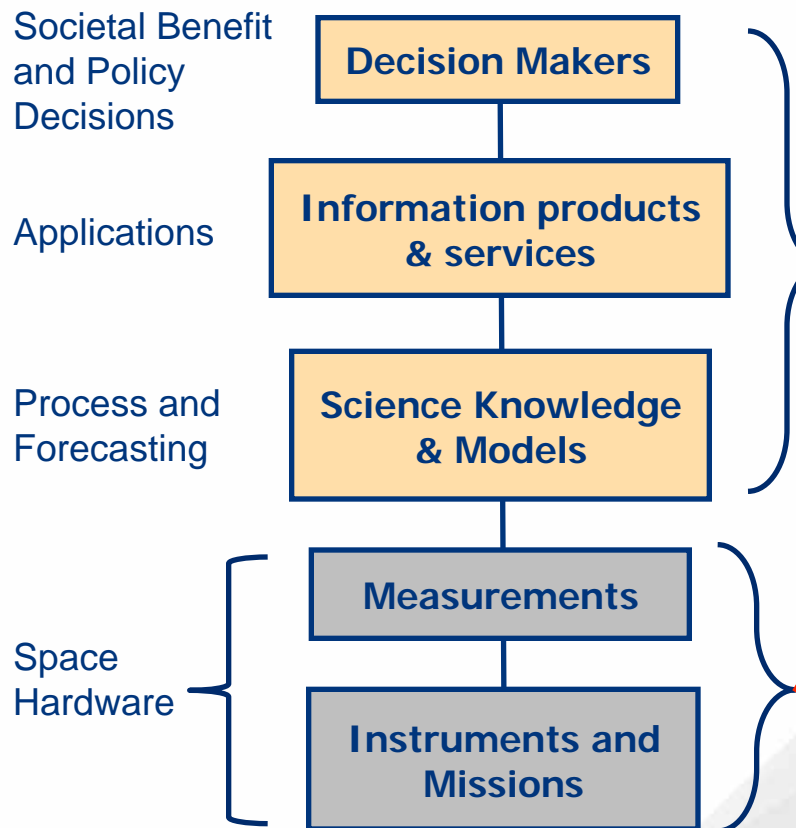
Measurement: Cloud optical depth  
GOS Reference: 016

Param Type	Application	Source	Accuracy (RMS)		$\Delta x$ (km)		$\Delta z$ (km)		$\Delta t$ (h)		$\delta$ (h)	
			thresh	break	thresh	break	thresh	break	thresh	break		
	NWP Global	EUM	50.00000	20.00000	50.00000	15.00000	N/A	N/A	12.00000	3.00000	6.00000	2.00000
	NWP Regional	EUM	50.00000	10.00000	20.00000	5.00000	N/A	N/A	6.00000	1.00000	0.50000	0.35000
	Climate	EUM	20.00000	10.00000	250.00000	50.00000	N/A	N/A	24.00000	6.00000	720.00000	72.00000
	Climate	WCRP	30.00000	20.00000	500.00000	200.00000	N/A	N/A	24.00000	18.00000	48.00000	36.00000
	Global Analytical Integration and Modeling	IGBP	5.00000	2.00000	500.00000	200.00000	N/A	N/A	12.00000	9.00000	12.00000	9.00000

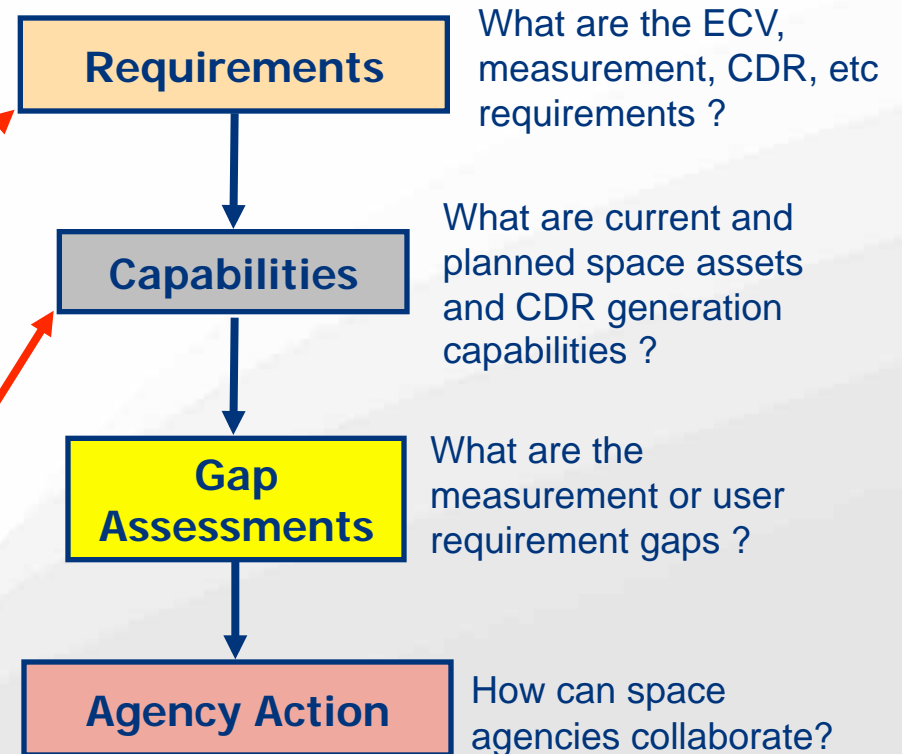
# Systems Approach



## Systems taxonomy for organization



## Strategy for collaboration and action



# General Mission Timeline Results – CO<sub>2</sub> Example



MIM CO<sub>2</sub> Measurement Timeline



SEO Detailed Gap Analysis for CO<sub>2</sub>

Mission	Instrument	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
<b>Nadir Absorption, weighted to the Lower Troposphere</b>																
ENVISAT	SCIAMACHY															
GOSAT	TANSO-FTS															
OCO-2	OCO Spectrometer															
Minicarb	FTS															
GOSAT-2	FTS															
CarbonSat	Spectrometer															
GOSAT-3	Laser Spectrometer															
<b>Nadir Emission, weighted to the Mid-Troposphere and Upper-Troposphere</b>																
EOS-AQUA	AIRS / AMSU															
EOS-AURA	TES															
METOP and NOAA	HIRS	5	5	4	4	3	3	2								
Metop (A,B,C)	IASI															
FY-3 (C,D,E,F,G)	IRAS				2	2	3	2	3	2	3	2	2			
NPOESS (1,3,4)	CrIS								2	2	3	2	2	2	2	2

Potential gaps here due to older current missions and uncertainty of new missions to measure lower troposphere.

- Timelines from the MIM database (**LEFT**) do not capture all missions producing valid CO<sub>2</sub> measurements and do not accurately reflect gaps.
- SEO gap assessment (**TOP**) considered **instrument types** (measurement approach), **atmospheric layers**, and **detailed requirements** (accuracy, spatial resolution, temporal resolution).



# Database Limitations: Detailed Mission Capabilities



*Detailed information is not currently available in the MIM or Systems Databases so this step requires extensive web searches. Hopefully, in the future this level of detail will exist in the databases so this process can be automated.*

Mission	Instrument	Resolutions			Accuracy
		Spatial Sample $\Delta x$ (km)	Spatial Swath (km)	Temporal Repeat Cycle $\Delta t$ (hrs/days)	Total Troposphere Column
<b>Nadir Absorption, Total Troposphere Columns weighted to the Lower Troposphere</b>					
ENVISAT	SCIAMACHY	30 x 60	960	72 (3 days)	2% (8 ppm)
GOSAT	TANSO-FTS	10.5	790*	72 (3 days)	1% (4 ppm)
OCO-2	OCO Spectrometer	1.3 x 2.25	10	384 (16 days)	0.25% (1 ppm)
Minicarb	FTS	8 x 16	TBD	TBD	0.25% (1 ppm)
GOSAT-2	FTS	10.5	790 (1)	72 (3 days)	1% (4 ppm)
CarbonSat	Spectrometer	2.0 x 2.0	500	144 (6 days)	0.5% (2 ppm)
ASCENDS	Laser Spectrometer	0 (2)	0 (2)	384 (16 days)	0.25% (1 ppm)
GOSAT-3	Laser Spectrometer	0**	0**	TBD	TBD
<b>Nadir Emission, Total Troposphere Columns weighted to the Mid-Troposphere and Upper-Troposphere</b>					
EOS-AQUA	AIRS / AMSU	13	1620	12 hours	0.4% (1.5 ppm)
EOS-AURA	TES	0.5 x 5.0	50	384 (16 days)	0.3% (1.3 ppm)
METOP and NOAA	HIRS	10	2240	12 hours	1% (4 ppm)
Metop (A,B,C)	IASI	12	2052	12 hours	0.5% (2 ppm)
FY-3 (C,D,E,F,G)	IRAS	17	952	12 hours	0.5% (2 ppm)
NPOESS (1,3,4)	CrIS	14	2200	12 hours	0.5% (2 ppm)

# CDR Inventory Database Next Steps



- **Add data from other agencies**
- **Review the existing data for errors**
- **Provide additional detailed information like maturity index data, calibration instrument sources, etc.**
- **Work with the CEOS MIM team to ensure all necessary linkages from instruments to measurements exist**
- **Develop a survey and/or work with MIM team to incorporate the ECV data into the annual EO Handbook Data Call**
- **Additional query ability to view data by measurement products, source instruments, agencies, etc**
- **Anything else?**