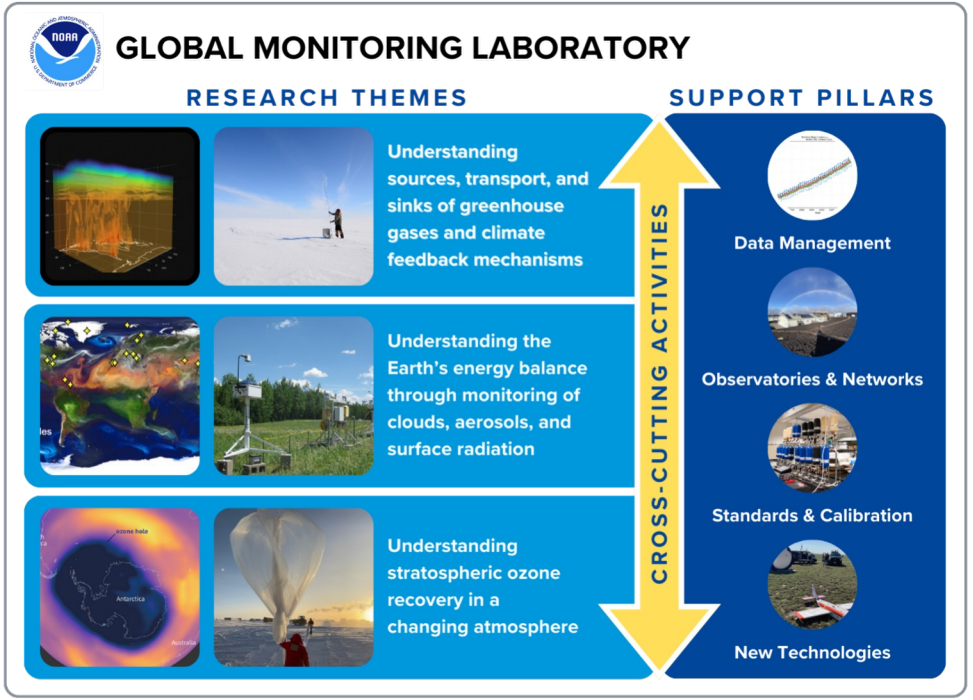
NOAA RESEARCH

Cross-Cutting Activities

Introduction – Brian Vasel

- Supporting pillars cross all 3 themes to directly support science and mission
- Highlight 3 supporting pillars
  - Calibrations - Brad Hall
  - Networks - Christine Smith
  - Data - John Mund
- Additional cross-cutting activities
- Summary



Cross-Cutting Activities

Standards and Calibrations

Brad Hall

NOAA RESEARCH

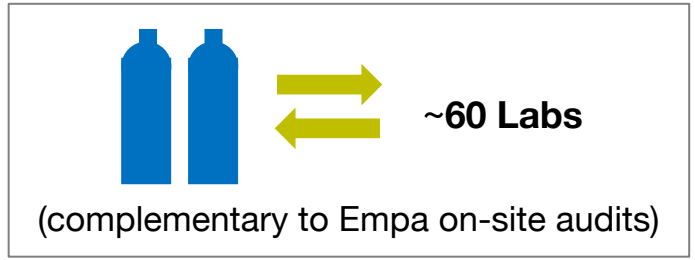
Trace gases, column ozone, radiation, and aerosols

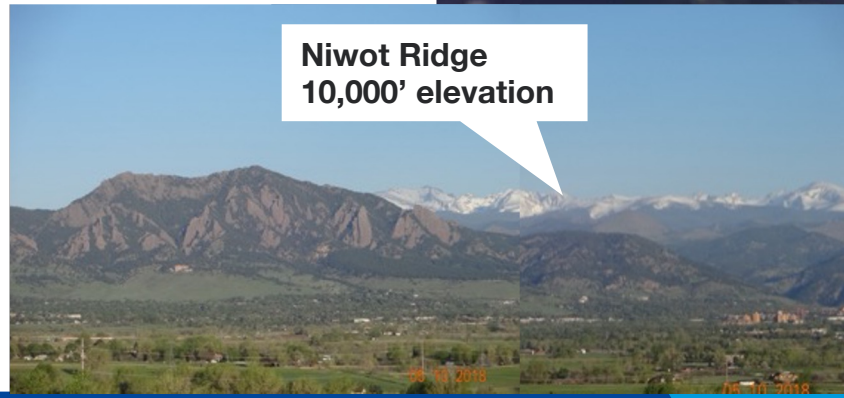
Common elements among calibration activities

- **Underpin** our long-term measurements (essential to interpret long-term trends, small gradients)
- Help **ensure compatibility** among networks
- **Global reach**
- Research component
- Transparency

Gases: Compressed gas standards

- GML maintains in-house calibration scales for ~60 gases
- We are a **WMO Central Calibration Laboratory**
  - for CO_2, CH_4, N_2O, CO, and SF_6
- GML distributes calibrated whole-air standards
  - **~350 standards per year (about half used by GML)**
  - **Support WMO Network Compatibility Goals** (e.g. 0.1 ppm CO_2)
  - Facilitate WMO Round Robin Experiments





Gases: Collaborations with National Metrology Institutes

Active participation in the Gas Analysis Working Group

- BIPM (International Bureau of Weights and Measures)

BIPM developed their own CO_2 manometric system

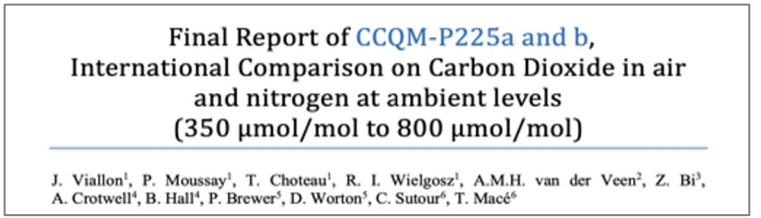
- We helped them characterize it
- To be used for on-demand comparisons
- Comparison of carbon dioxide in air reference **scales**

IOP Publishing | Bureau International des Poids et Mesures — Metrologia

Metrologia 55 (2018) S174–S181 — https://doi.org/10.1088/1681-7575/aad830

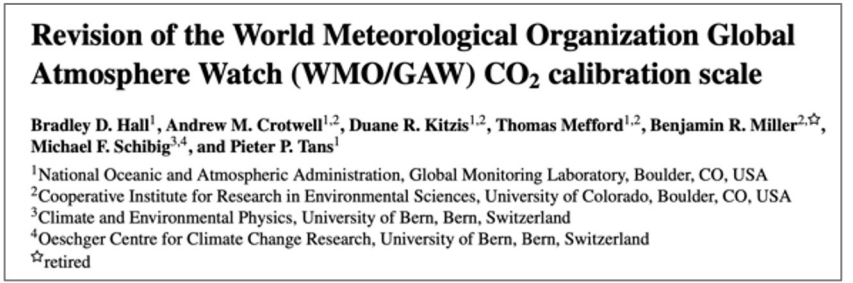
SI traceability and scales for underpinning atmospheric monitoring of greenhouse gases

Paul J Brewer[1,6], Richard J C Brown[1], Oksana A Tarasova[2], Brad Hall[3], George C Rhoderick[4] and Robert I Wielgosz[5]



Final Report of CCQM-P225a and b,
International Comparison on Carbon Dioxide in air and nitrogen at ambient levels
(350 µmol/mol to 800 µmol/mol)

J. Viallon[1], P. Moussay[1], T. Choteau[1], R. I. Wielgosz[1], A.M.H. van der Veen[2], Z. Bi[3], A. Crotwell[4], B. Hall[4], P. Brewer[5], D. Worton[5], C. Sutour[6], T. Macé[6]



Revision of the World Meteorological Organization Global Atmosphere Watch (WMO/GAW) CO_2 calibration scale

Bradley D. Hall[1], Andrew M. Crotwell[1,2], Duane R. Kitzis[1,2], Thomas Mefford[1,2], Benjamin R. Miller[2,☆], Michael F. Schibig[3,4], and Pieter P. Tans[1]

[1]National Oceanic and Atmospheric Administration, Global Monitoring Laboratory, Boulder, CO, USA
[2]Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, CO, USA
[3]Climate and Environmental Physics, University of Bern, Bern, Switzerland
[4]Oeschger Centre for Climate Change Research, University of Bern, Bern, Switzerland
☆retired

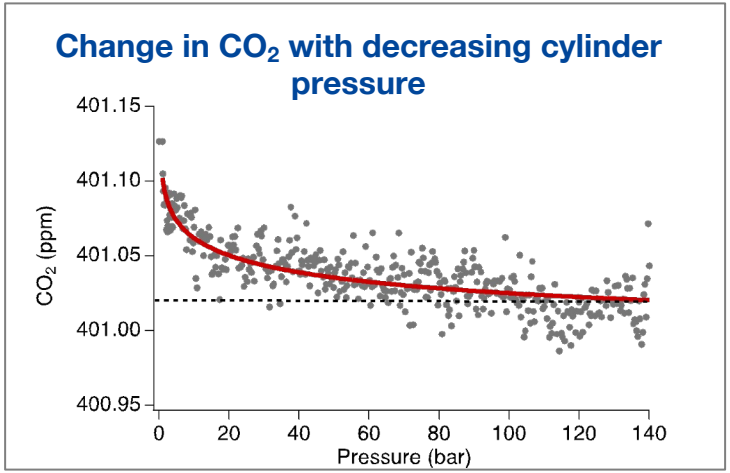
Gases: Research component

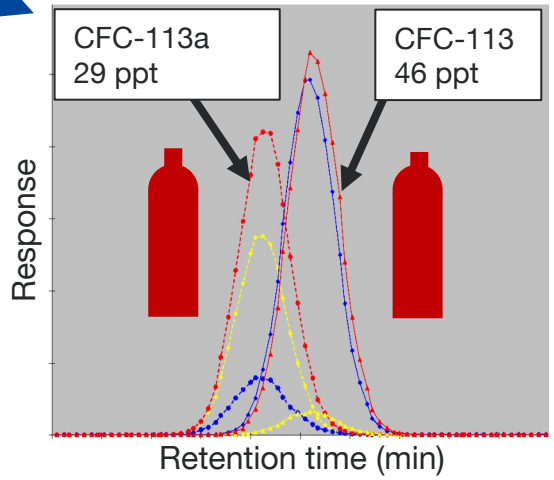
- Stability of gases in high-pressure cylinders
- Development of one-step method for gravimetric CO_2 standards
- Co-elution of ethane with SF_6
- Co-elution of CFC isomers (CFC-113/CFC-113a)

Information Sharing

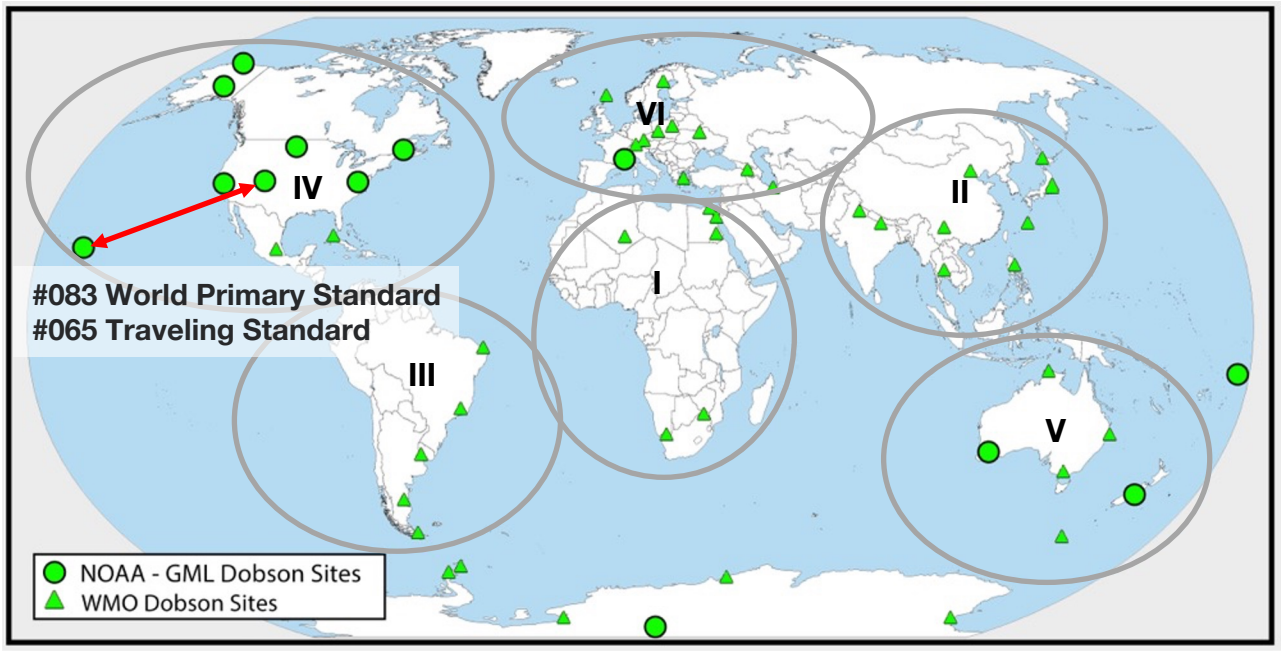
- Working Groups
- AGAGE group
- WMO GGMT
- Peer-review literature

Large inventory of standards





Column ozone: Dobson Network



South Africa 2019

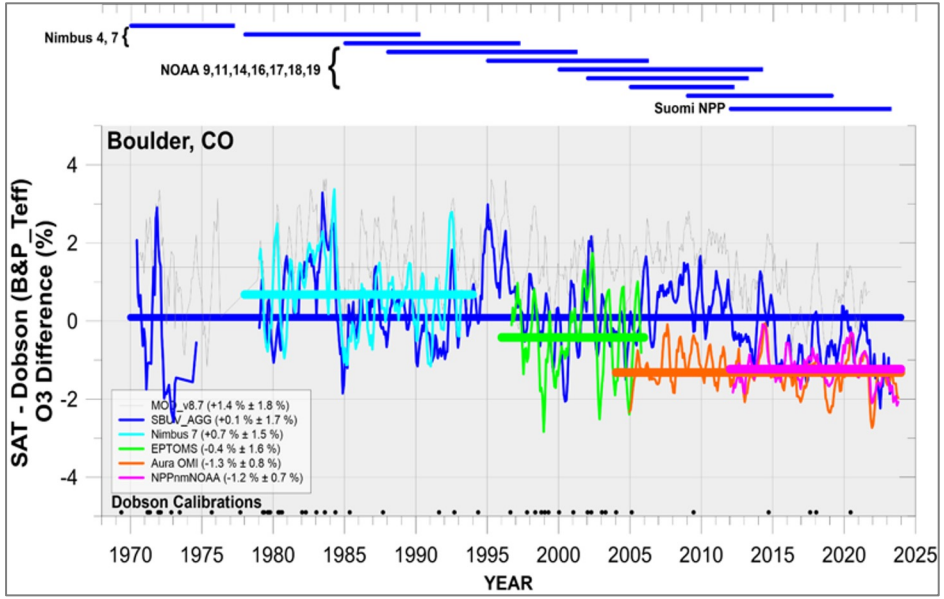
Argentina 2019, *2025*

Germany/Czech Rep. 2021

Australia 2022

Japan 2022

Column ozone: Traceability to the world standard



- Used to **establish consistency** of measurement across networks
- Important for assessments, trend detection
- **Continuity across satellite transitions**
- **Evaluate** other instruments (e.g., Pandora)

Atmos. Chem. Phys., 17, 12051–12070, 2017
https://doi.org/10.5194/acp-17-12051-2017

Atmospheric Chemistry and Physics
EGU

Technical note: The US Dobson station network data record prior to 2015, re-evaluation of NDACC and WOUDC archived records with WinDobson processing software

Robert D. Evans[2], Irina Petropavlovskikh[1], Audra McClure-Begley[1], Glen McConville[1], Dorothy Quincy[2], and Koji Miyagawa[3]

[1]Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, CO 80309, USA
[2]Retired from NOAA/ESRL, Global Monitoring Division, Boulder, CO 80305, USA
[3]Visitor with NOAA/ESRL, Global Monitoring Division, Boulder, CO 80305, USA

Solar radiation: Solar Radiation Calibration Facility (SRCF)

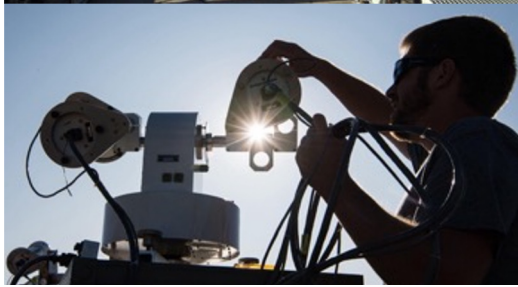
WMO Region IV Calibration Center for the US since the late 1970s

Facilities and Capabilities

- Maintain and operate the **reference active cavity radiometer triad** for WMO region IV
- **Traceable to the WMO World Radiometric Reference (WRR)**
- Participate in the International Pyrheliometer Comparison in **Davos, Switzerland every five years**
- Participate in the National Pyrheliometer Comparison (NPC) at **DOE NREL, Golden, CO every year**

Future Directions

- **Upgrade calibration datalogging system** for next generation instrumentation
- **Expand capacity** to respond to requests from partners



~ 100 solar radiometers per year for NOAA laboratories (e.g., GML, PSL ARL), federal agencies, and academia (e.g., NCAR)

Solar radiation: Central UV-Vis Calibration Facility (CUCF)

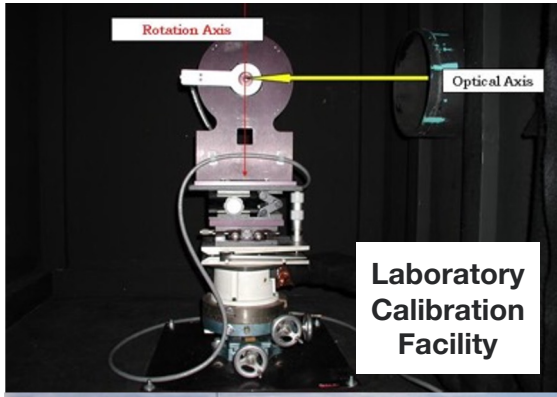
WMO UV Regional Calibration Center for the United States. Central Calibration Facility developed in collaboration with NIST in early 1990s.

Facilities and Capabilities

- **CUCF Laboratory**, Table Mountain Test Facility (TMTF), and a Hi-Altitude Observatory
- **Horizontally calibrated spectral lamps** for interagency and academic partners for traceability to NIST standards
- **Instrument Characterizations** - Spectral response, angular response
- **Field Calibration Unit** for UV calibration transfers in the field

Future Directions

- **Upgrade aging CUCF laboratory benches** to ensure instrument performance and expand/upgrade in visible wavelength region

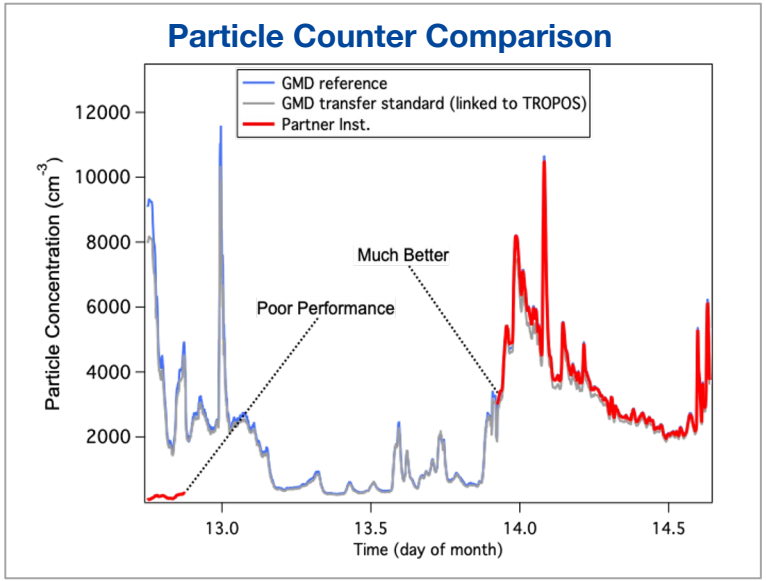


Laboratory Calibration Facility


Table Mountain Test Facility

Aerosols: NOAA Federated Aerosol Network

- GML's calibration role: **Network support**, **QA/QC**, and capacity-building
- Calibration derived from World Calibration Center for Particle Physics
- Planning for a calibration at WCCPP in December 2024



Summary:

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- Calibration activities play an important role at GML and around the world
- GML provides references for satellite products
- GML leads and participates in comparisons
- GML supports long-term, high-quality measurements, and efforts to meet network compatibility goals
- GML collaborates with many laboratories, including National Metrology Institutes

Cross-Cutting Activities

Observatory and Global Network Operations Division

Christine Smith

Overview

- Observatory and Global Network Operations Overview (OBOP)
- Review Question 2: Structure and Resources
  - Atmospheric Baseline Observatories
  - Atmospheric Measurement Network
- Review Question 4: Routine, Reliable, Robust GHG Monitoring
  - Investment in Measurement Infrastructure
  - Focus on Modular and Interoperable Systems
- Review Question 5: Diverse Community Participation
  - Community Outreach

OBOP: Facilitating science

Providing logistical, project management, and technical support

- Field operations
- Shipping & logistics
- Facility maintenance
- Lease agreements & contracts
- Partner scientific support agreements (MOUs, IAAs)

Atmospheric Baseline Observatories (ABO)

- The “backbone” of GML global networks
  - Co-located instruments
  - Fundamental measurements
  - Clean Air Sector - background conditions
- Provide infrastructure and support
  - GML science divisions
  - Over 80 partner projects
- Known for …
  - Stable infrastructure in remote locations
  - Well-trained NOAA technicians
  - Superior customer service

Atmospheric Measurement Network (AMN)

- Operational leaders of the NOAA Global Greenhouse Gas Reference Network (GGGRN) measurements
- Operational lead for each sub-network, ensuring “health of the network”
  - Aircraft - 15 sites
  - Tall towers - 14 sites
  - Surface flask - 54 sites
- Direct link to science lead, evaluates and executes operations
  - Technical staff - troubleshooting, repairs, upgrades
  - Logistical staff - shipping/receiving/flask prep and analysis

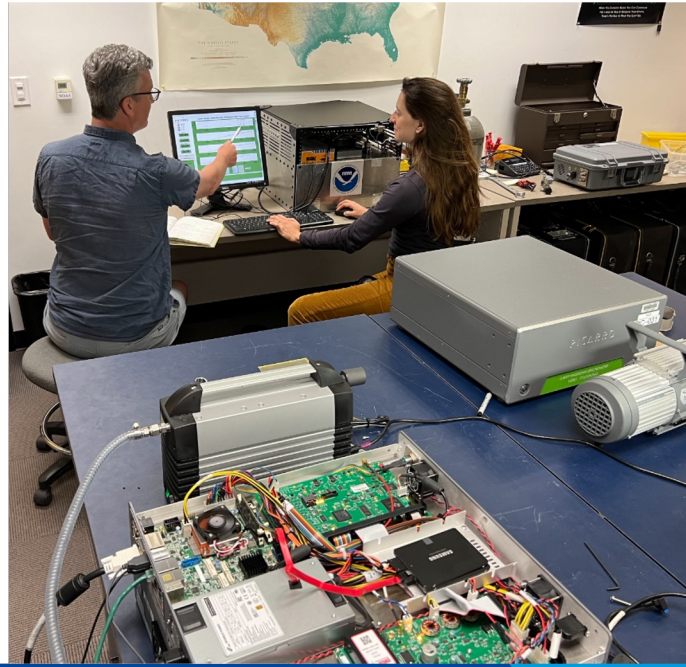
Investment in measurement infrastructure

- Facility upgrades
  - ABO deferred maintenance
  - Site plans focusing on efficiencies and sustainability
- AMN agreements and instruments
  - Long-term leases and support agreements
  - Modernizing the GHG measurement systems

Ensuring the backbone of the networks supports GML, the GGGRN, and partners for the next 50+ years

Focus on modular and interoperable systems

- Simplifying maintenance and enable rapid replacement
- Sharing instrument system components and software across divisions
  - More purchasing power
  - Greater on-hand inventory
  - Shared knowledge
- Cross-trained personnel
  - Programming
  - Technical skill
  - Project management



Community outreach

GML ABO staff work in, and are members of remote communities, engaging with local communities.

- Public tours
  500+ visitors per year at MLO
- Student engagement

Outreach is enhanced with NOAA line office collaborations.

Summary:

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- The OBOP Division's purpose:
  "Focus on operations so scientists can focus on research."
- OBOP is investing in measurement infrastructure through instrument and facility modernization.
- Proactively choosing modularity and interoperability creates efficiencies within GML networks.

Cross-Cutting Activities

Data Management

John Mund

Are GML's datasets easily findable, accessible, interoperable, and reusable, and its data products relevant for stakeholders?

Are the data management activities optimally organized?

Overview

- Goals of good data management
- Lab-wide data management assessment
- Highlights and examples
- Where we are headed

Data distribution

National Centers for Environmental Information
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

World Ozone and Ultraviolet Radiation Data Centre

WRMC-BSRN
World Radiation Monitoring Center - Baseline Surface Radiation Network

WMO Global Atmosphere Watch
World Data Centre for Aerosols

WDCGG
World Data Centre for Greenhouse Gases

Data usability

FAIR Principles

GO FAIR is committed to making data and services **findable**, **accessible**, **interoperable** and **reusable (FAIR)**.

Findable: Metadata and data should be easy to find for both humans and computers.

Accessible: The exact conditions under which the data is accessible should be provided in such a way that humans and machines can understand them.

Interoperable: The (meta)data should be based on standardized vocabularies, ontologies, thesauri etc. so that it integrates with existing applications or workflows.

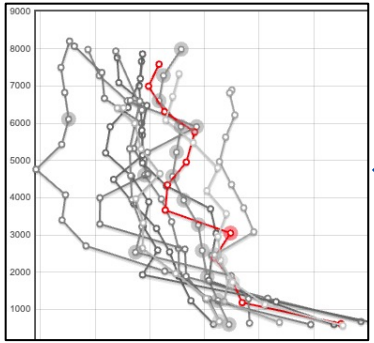
Reusable: Metadata and data should be well-described so that they can be replicated and/or combined in different research settings.

GO FAIR

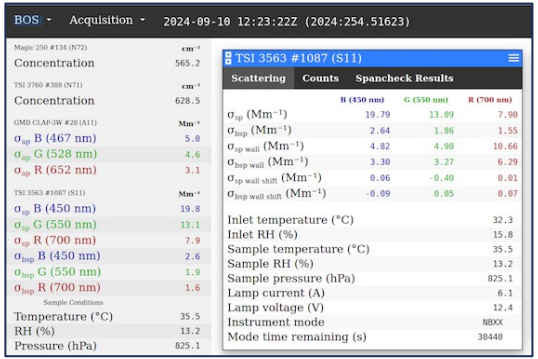
https://www.go-fair.org/

Data management for long-term monitoring

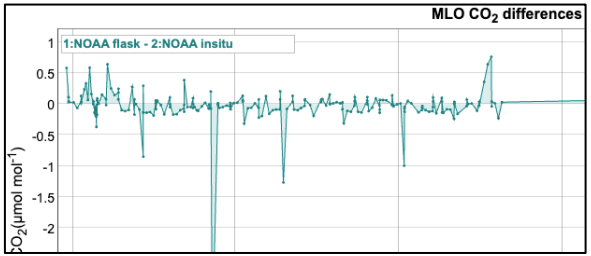
Analysis



Quality control



Inter-comparisons



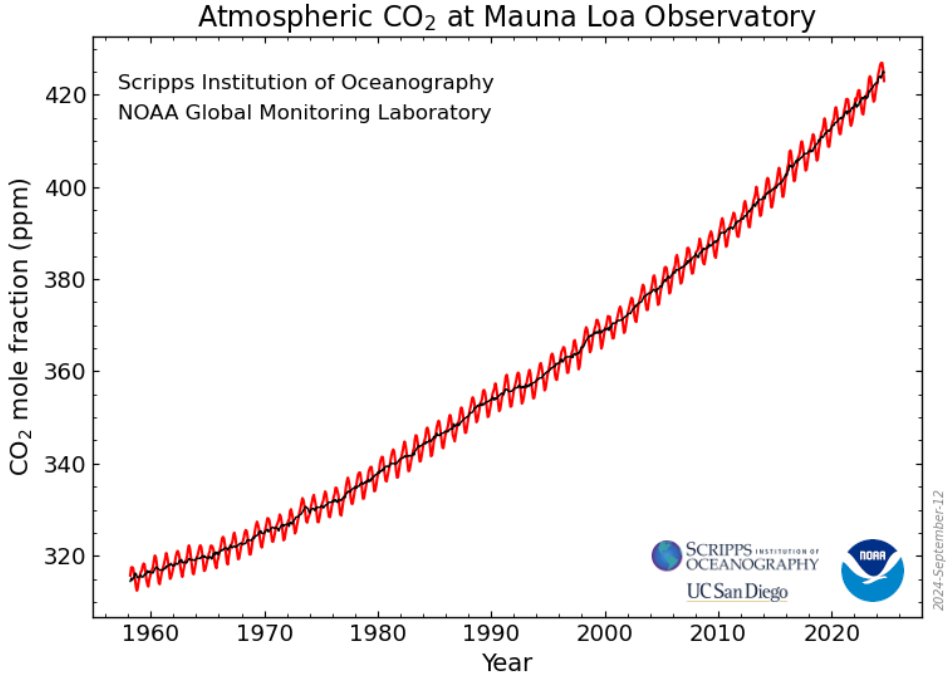
Logistics

873 flasks in analysis loop. 70 additional flask(s) have been checked in but not processed (nc

ID	Site	Date in	Project	Path	Stop 1	Stop 2
3928-99	ASC	2024-08-26	ccg_surface	1,2,3,10,15	MAGICC (15 days)	co2c13
2816-99	CPT	2024-08-21	ccg_surface	1,2	MAGICC (20 days)	co2c13
4783-99	MHD	2024-08-19	ccg_surface	1,2,3	MAGICC (22 days)	co2c13

Data management for long-term monitoring

In 20 years will your successor be able to reprocess the data that you produced today?



GML data management assessment

The committee had four primary objectives:

1. Create a comprehensive catalog of all data products produced in GML
2. Assess whether current practices meet federal record keeping requirements and best practices
3. Determine whether our data is published using FAIR data principles (Findable, Accessible, Interoperable, and Reusable)
4. Provide recommendations on how GML can meet our obligations, improve data distribution, and optimize data management across the lab.

GML data management assessment

- GML has > 4,800 datasets available for download
- Most federal record keeping requirements and technical aspects of FAIR data delivery are met through our NCEI Archive
- Data is well managed in most groups but inconsistent across the lab
  - Resources are not evenly distributed
  - Providing data management resources allows researchers to focus on core competencies

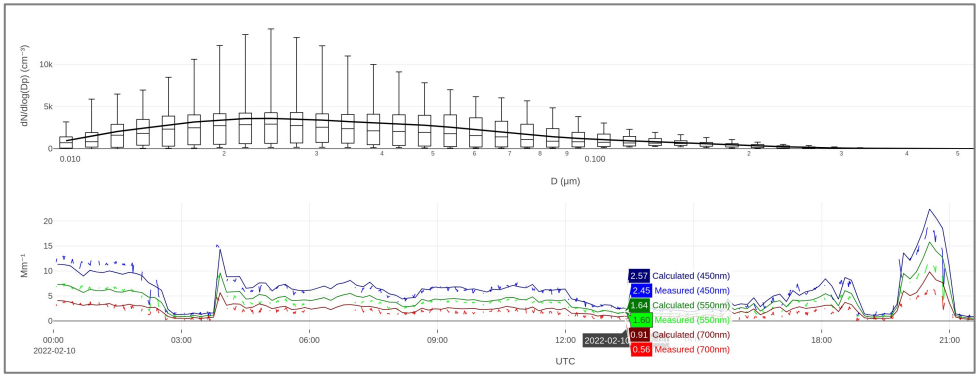
Data processing

Data processing and ability to reprocess historical data is consistently good across the lab.

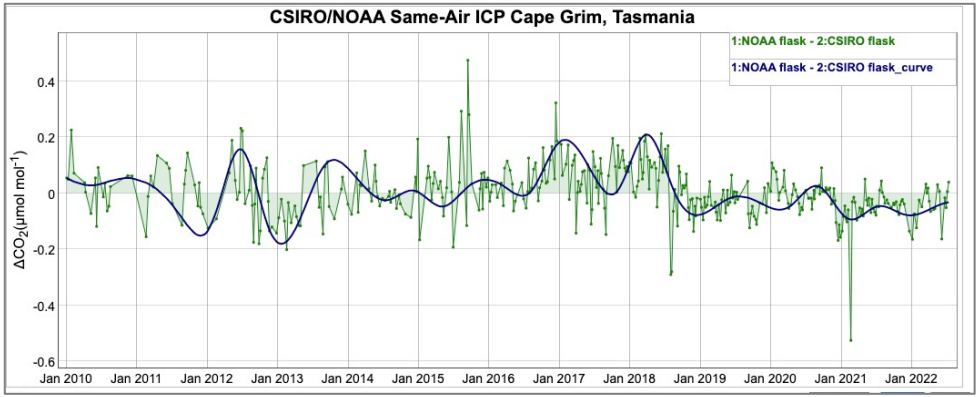
Examples:

- NFAN (NOAA Federated Aerosol Network) provides centralized processing for GML and collaborator sites
- The carbon cycle group is expanding its best-in-class observatory in-situ processing system to apply best practices to all our in-situ measurements including tall tower and commercial aircraft

Data storage and analysis optimized for our datasets



The aerosols and ozone ingest system processes ~4,500 data points per minute (>2.3 billion/year).

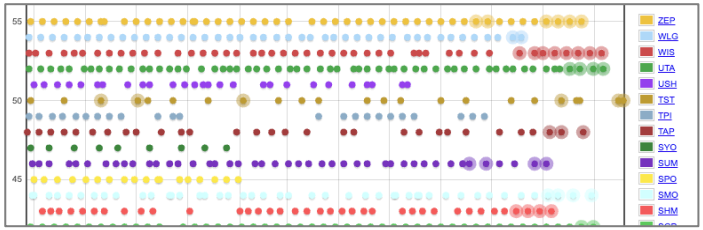


The ICP program includes 224,225,379 GGGRN and 40,475,105 partner measurements from 149 sites, 44 of which are co-located with partner programs.

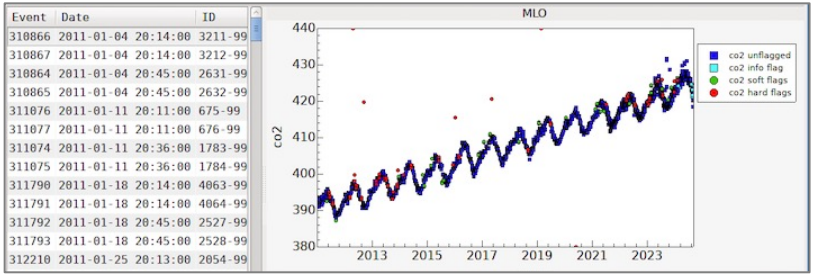
Data analysis and quality control

Greater use of structured databases is an ongoing project to enable powerful tools to manage operations, data access and document data provenance.

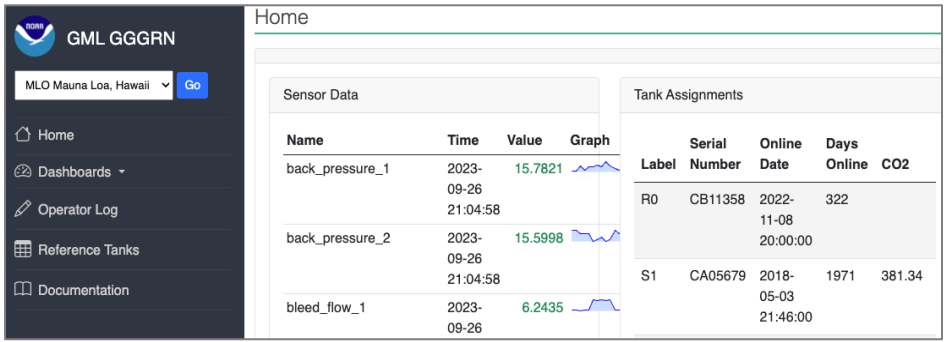
Site sample density



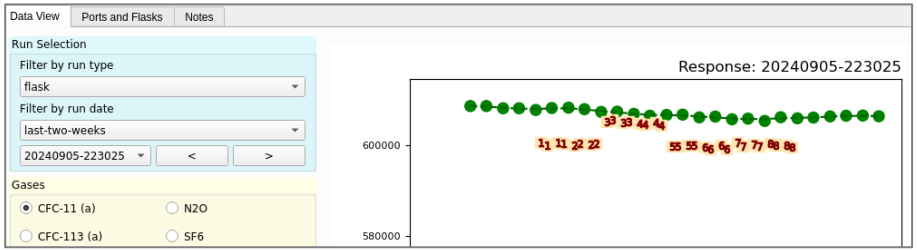
Data flagging



Dashboards



Processing



Data provenance

CCL tank assignment change history records provenance through design of the repository

Calibrated tank assignment history

scale	serial_number	fill_code	start_date	assign_date	current	zero	coef0	coef1	coef2
CO2_X2019	10932	A	1984-01-01	2020-11-12 00:00:00	1	1984.000000	335.309000	0.113900	0.000000
CO2_X2019	10932	B	1988-10-07	2017-07-18 00:00:00		1985.638428	359.091000	-0.118200	0.051900
CO2_X2019	10932	B	1988-10-07	2019-07-23 00:00:00		1985.638428	359.007000	-0.042100	0.036900
CO2_X2019	10932	B	1988-10-07	2020-02-25 00:00:00		1987.985840	359.069000	0.120699	0.054826
CO2_X2019	10932	B	1988-10-07	2020-03-12 00:00:00		1987.985840	359.086000	0.046500	0.000000
CO2_X2019	10932	B	1988-10-07	2020-04-07 00:00:00		1987.985840	359.086000	0.046500	0.000000
CO2_X2019	10932	B	1988-10-07	2020-08-11 00:00:00		1987.985840	359.119000	0.055100	0.000000
CO2_X2019	10932	B	1988-10-07	2020-10-22 00:00:00		1987.955444	359.134000	0.053700	0.000000
CO2_X2019	10932	B	1988-10-07	2020-10-29 00:00:00	1	1987.437012	359.120000	0.071200	0.000000
CO2_X2019	11017	A	1983-02-11	2020-11-05 00:00:00		0.000000	343.810000	0.000000	0.000000
CO2_X2019	11017	A	1983-02-11	2020-11-12 00:00:00	1	1983.000000	343.807000	0.000000	0.000000

Data availability

ObsPack (Observation Package)

- One of the primary methods to distribute CO_2 and methane data for global and regional models.
- We are actively collaborating with WMO Global Greenhouse Gas Watch (G3W) to ensure data availability

GLOBALVIEWplus 10.0

- 675 datasets
- 79 labs in 28 countries (248 PIs)
- Self-describing meta data
- Programmatically readable
- Over 40 million measurements
- Clear attribution and citation requirements

Data relevance

Summarizing our immense data archive for policy makers, industry, educators and the public

NOAA Annual Greenhouse Gas Index (AGGI) Tracks the amount of heat being added to the atmosphere by human-related emissions

The NOAA Ozone Depleting Gas Index (ODGI) Tracks the progress of ozone layer recovery

Mauna Loa Apparent Transmission Atmospheric Transmission of Direct Solar Radiation at Mauna Loa, Hawaii

Barrow Snow Onset and Melt Date Trends Use daily albedo measurements to track the impact of rising temperatures on Arctic snowpack

Global Trends in CO_2 & CH_4 Monthly means globally averaged over marine surface sites

Information and Activities for Earth Science Students and Teachers Teaching guides, student handouts and background information

CarbonTracker CarbonTracker is a global model of atmospheric carbon dioxide and methane with a focus on North America

US Emission Tracker for Potent GHGs Tracking emissions over the contiguous U.S.

Summary:

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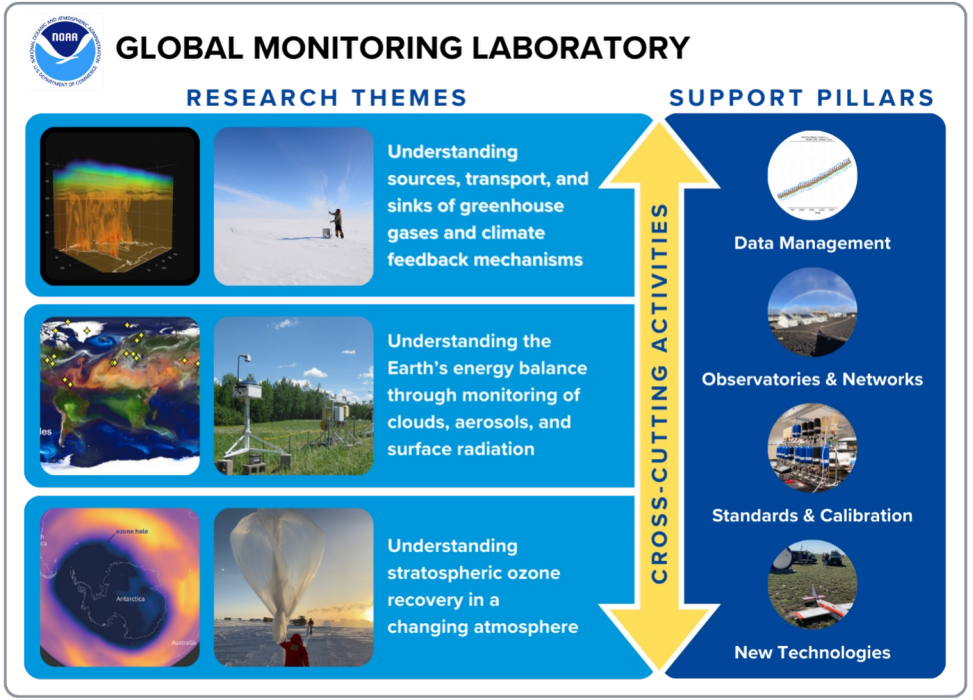
Are GML's datasets easily findable, accessible, interoperable, and reusable (FAIR), and its data products relevant for stakeholders?

Are the data management activities optimally organized?

- NCEI archives provide FAIR data distribution
- We are community leaders in making our data available and easy to use for modelers, researchers and scientists
- We apply our expertise in interpreting our data so that we can inform policy makers, educators and industry leaders
- We have mature data management practices honed from decades of operations

Outline

- Supporting pillars cross all 3 themes to directly support science & mission
- Highlight 3 supporting pillars
  - Calibrations - Brad Hall
  - Networks - Christine Smith
  - Data - John Mund
- Additional cross-cutting activities
- Summary



Additional cross-cutting activities

Technological innovation

- Creation of TTEA division in 2023
- Innovation is happening across GML
- Resource to better position for future needs

DEIA

- Fostering an inclusive and equitable workforce and workplace
- GML committee meeting model (prior session this morning session)
- Future goals to strengthen connections with partners

Additional cross-cutting activities

Laboratory leadership

- Overall scientific direction
- Connections across themes and supporting activities
- Communications, outreach, international collaboration, etc.

Administration

- Budget, purchasing, agreements, property, etc.

IT

- Network, help desk, security, etc.

Additional cross-cutting activities

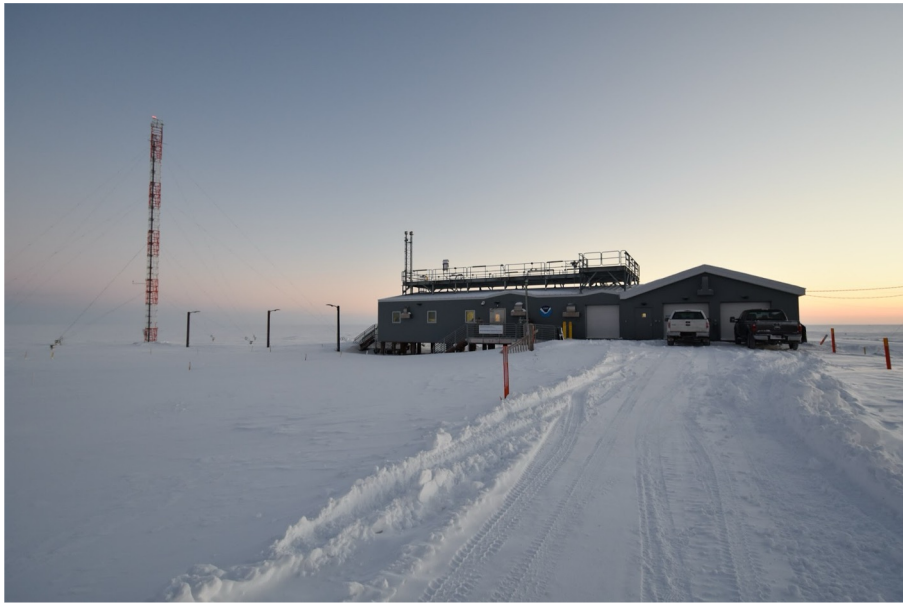
Safety

- Internal expertise
- Incorporating into project planning
- Aircraft/balloon operations
- Trainings – unique field requirements
- Inventory management
- Incident/injury reporting
- Job hazard analyses (JHAs)
- Radiation safety program

Additional cross-cutting activities

Sustainability and net-zero efforts

- ABOs
  - BRW - LEED Silver
  - MLO - DOE AFFECT
  - SMO - Proposed DOE
- GML-wide
- WMO’s new SG-EnvS



Summary:

NOAA RESEARCH

- In this session you heard …
  - Calibrations are essential and underpin our long-term measurements.
  - Operational structure with OBOP teams supporting science.
  - GML's data management philosophy and future directions.
  - Efforts to incorporate safety and sustainability more into what we do.
  - The supporting pillars are foundational to how GML is structured and operates.
- GML is world-class and unique.