

Carbon Dioxide, Methane & Other Greenhouse Gases

ESSENTIAL CLIMATE VARIABLE (ECV) FACTSHEET



ECV IN BRIEF

- Domain:** Atmosphere
- Subdomain:** Atmospheric Composition
- Scientific Area:** Carbon cycle and other GHGs
- ECV Stewards:** Paolo Laj, Dale Hurst
- Products:** Tropospheric CO₂ column
Tropospheric CO₂
Tropospheric CH₄ column
Tropospheric CH₄
Stratospheric CH₄

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The atmospheric abundance of carbon dioxide (CO₂), the dominant human-produced greenhouse gas, has increased by about 50% since pre-industrial times due to the proliferation of fossil fuel combustion. Methane (CH₄) is also a strong greenhouse gas; its atmospheric abundance has more than doubled since the pre-industrial era because of human activities. Other significant greenhouse gases include nitrous oxide (N₂O), chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF₆).

ECV Product¹

PRODUCT	DEFINITION	REQUIREMENTS				
		FREQUENCY	RESOLUTION	REQUIRED MEASUREMENT UNCERTAINTY	STABILITY	STANDARDS/ REFERENCES
Tropospheric CO₂ column	Molecules of CO ₂ in the atmosphere from surface to Tropopause (Molecules/cm ²)	4hr	5-10km/NA	1ppm	1.5ppm/decade	ESA CCI CMUG tables (http://www.esa-cmug-cci.org/)
Tropospheric CO₂	Dry air mole fraction of CO ₂ in the troposphere (Mol/mol)	4hr	5-10km/5km	1ppm	1.5ppm	
Tropospheric CH₄ column	Total molecules of CH ₄ in the atmosphere from surface to Tropopause (Molecules/cm ²)	4hr	5-10km/NA	10ppb	7ppb	

¹ Current Products and Requirements as in the Implementation Plan 2016 (GCOS-200). GCOS is reviewing and will update the requirements until 2022. More information on: gcos.wmo.int and climatedata.wmo.int.

Tropospheric CH₄	Dry air mole fraction of CH ₄ in the troposphere (Mol/mol)	4hr	5-10km/5km	0.5ppb	0.7ppb	
Stratospheric CH₄	Dry air mole fraction of CH ₄ in the stratosphere (Mol/mol)	daily	100-200km/2km	5%	0.30%	

Data Sources²

In Situ Data:

- ▶ NOAA Earth System Research Laboratory Global Monitoring Division Greenhouse Gas data
<https://www.esrl.noaa.gov/gmd/dv/iadv/>
- ▶ Network for the Detection of Atmospheric Composition Change (NDACC)
<http://www.ndsc.ncep.noaa.gov/>
- ▶ Total Carbon Column Observing Network (TCCON)
<http://tccodata.org/>
- ▶ World Data Centre for Greenhouse Gases (WDCGG)
<http://ds.data.jma.go.jp/gmd/wdcgg/>

Reanalysis:

- ▶ REANALYSES.ORG (Inventory for Reanalysis)
<http://reanalyses.org>
- ▶ Monitoring Atmospheric Composition & Climate (MACC), European Centre for Medium-Range Weather Forecasts (ECMWF)
<http://apps.ecmwf.int/datasets/data/macc-ghg-inversions>
- ▶ Copernicus Atmospheric Monitoring Service (CAMS), European Centre for Medium-Range Weather Forecasts (ECMWF)
<http://apps.ecmwf.int/datasets/data/cams-ghg-inversions/>

Satellite:

- ▶ Satellite ECV Inventory by the CEOS/CGMS Working Group on Climate (WGClimate)
<http://climatemonitoring.info/ecvinventory>

Atmospheric CO₂ at Mauna Loa

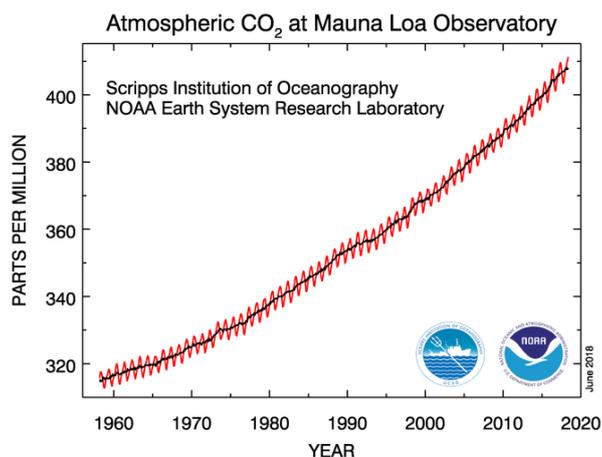


Figure: Monthly mean atmospheric carbon dioxide at Mauna Loa Observatory, Hawaii

Source: The carbon dioxide data (red curve), measured as the mole fraction in dry air, on Mauna Loa constitute the longest record of direct measurements of CO₂ in the atmosphere. They were started by C. David Keeling of the Scripps Institution of Oceanography in March of 1958 at a facility of the National Oceanic and Atmospheric Administration [Keeling, 1976]. NOAA started its own CO₂ measurements in May of 1974, and they have run in parallel with those made by Scripps since then [Thoning, 1989]. The black curve represents the seasonally corrected data.

Data are reported as a dry mole fraction defined as the number of molecules of CO₂ divided by the number of molecules of dry air multiplied by one million (ppm).

² This list provides sources for openly accessible data sets with worldwide coverage for which metadata is available. It is curated by the respective GCOS ECV Steward(s). The list does not claim to be complete. Anyone with a suitable dataset who would like it to be added to this list should contact GCOS.

