Estimated amount of data (per orbit, per satellite):
Number of measurements:
~1.1 million
Level-1 product size (CO2-IS /NO2-IS):
~25 / 12 Gb
Number of clear sky retrievals:
~200,000
Level-2 product size (GHG / NO2):
~2 / 1 Gb
Product availability/timeliness
>95% / 24 h

VIS band also covers CHOCHO (glyoxal)
VIS & SWIR band also covers water vapour
*Top-of-Atmosphere Solar Induced Fluorescence

CO2M Product Processing and Interdependencies:

Three platforms operated in tandem to maximise coverage north of 40°
Agile platforms can be operated following the glint spot (increasing water-body surface reflectance)

Correspondence: Ruediger Lang, ruediger.lang@eumetsat.int
CO2M mission products for the Copernicus CO2 Monitoring and Verification Support Capacity

- **Observations**
  - Satellite CO₂ & CH₄ observations
  - Surface and airborne observations
  - Meteorological observations
  - Auxiliary observations

- **Prior Information**
  - CO₂ fluxes, model parameters, emission reports, economic statistics.

- **Integration**
  - Global integration & attribution
  - Evaluation & quality control

- **Decision support system**
  - Options for actionable measures at country and city scale

- **Output**
  - Consolidated Country/region Fossil Fuel emissions with uncertainties
  - Consolidated Hot-spot Fossil Fuel emissions with uncertainties

**CO2M Cal/Val external sources:**
- Other mission data
- Ground-based FRM data
- Model (analysis/forecast) data
Copernicus CO2M mission – processing and products

CO2M Product Processing and Interdependencies:

- **CO2M Product Processing and Interdependencies:**
  - **Level-1b**
  - **Level-1c**
  - **Level-2**
  - **Geo-location / Co-registration**
  - **ANCILLARY**
  - **Scientific processing task**

- **CO2M Product Processing and Interdependencies:**
  - **MAP Level1B**
  - **SWIR/NIR Level1B**
  - **VIS Level1B**
  - **NO2 Level1B**
  - **AER L2**

- **Cloud Mask Phase/Cirrus Radiances**

- **Level-1b**
- **Level-1c**
- **Level-2**
- **Geo-location / Co-registration**
- **ANCILLARY**
- **Scientific processing task**

CO2M Products requirements (MRD v3):

<table>
<thead>
<tr>
<th>Product</th>
<th>Spatial resolution</th>
<th>Precision</th>
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<tbody>
<tr>
<td>CO2</td>
<td>4 km²</td>
<td>0.7 ppm</td>
</tr>
<tr>
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<td>4 km²</td>
<td>10 ppb (est.)</td>
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<td>4 km²</td>
<td>1.5x10¹⁵ molec/cm²</td>
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<tr>
<td>SIF*</td>
<td>4 km²</td>
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</tr>
<tr>
<td>Aerosols</td>
<td>16 km²</td>
<td>0.05 AOD, 500 m LH</td>
</tr>
<tr>
<td>Clouds</td>
<td>&lt;5% of FOV</td>
<td>Water &amp; cirrus clouds</td>
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VIS band also covers CHOCHO (glyoxal)
VIS & SWIR band also covers water vapour
*Top-of-Atmosphere Solar Induced Fluorescence

Estimated amount of data (per orbit, per satellite):

- **Number of measurements:** ~1.1 million
- **Number of clear sky retrievals:** ~200,000
- **Level-1 product size:** ~20 Gb
- **Level-2 product size:** ~5 Gb
CO2M orbit and geo-location products for XCO2/XCH4

Glint-spot platform pointing:

Platform pitch angle profile (model scenarios TBC):

![Platform pitch angle profile](image)

Geo-location product, parallax correction:

Parallax correction for CO2-IS/NO2-IS level-1b [m]:

![Parallax correction](image)

Focus on high terrain for pitched orbit with slant observations

Affects mean surface altitude as well as geo-location

Use of Copernicus 9” DEM

Even more important for MAP L1C product

Top-Of-Atmosphere simulations for Copernicus CO2M
https://www.eumetsat.int/CO2M-TOA-TDS
Copernicus CO2M mission – level-1 radiance and cloud products

Level-1b NO2-IS:
Calibrated radiances
VIS (405 – 490 nm)

Level-1b CO2-IS:
Calibrated radiances
NIR (747 – 773 nm)
SWIR-1 (1590 -1675 nm)
SWIR-2 (1990 -2095 nm)

Level-1b MAP:
Calibrated pol. radiances
(410 443 490 555 670 (753) 865 nm)

Level-1c MAP:
Multi-view I,Q,U radiances at CO2-IS footprint

Level-1b CLIM:
Calibrated radiances
(670 753 1320 nm)
Cloud and cirrus flag / cloud and cirrus obstruction at native resolution

Level-2 CLIM:
Aggregated cloud and cirrus obstruction at CO2-IS resolution:
- Cloud fraction (geometric)
- Cloud top height (TBD)
- Cloud obstruction (radiometric)
- Scene inhomogeneity (std of imager radiances)

Additional cloud information:
- CO2-IS NIR: Oxygen A-Band
- NO2-IS: (O2)2 absorption
- MAP: I, Q, U (Rainbow, cloud type, ...)
- CO2-IS SWIR: cirrus
Copernicus CO2M mission – level-2 products

**CO2M GHG level-2 product: XCO2 / XCH4**

- **Baseline Algorithm**
- **Auxiliary Algorithms 1**
- **Auxiliary Algorithms 2**
- Product and uncertainty processing

**GOSAT XCO2**

- Baseline products
- XCO2, XCH4, and other products
- Product uncertainty

**Cal/Val**

- Socotra
- East Taw Lake
- Boraon
- Bohol
- Sarawak
- James
- Guanartem-Pedernales
- Man Fells
- Pilawas
- Intarabien
- Grand Casimir
- Larder
- Turola
- Turtle
- Pabana
- Kids
- Hulon
- Aserine Inlet
- Serad
- Redonda
-声明
- Overall

**CO2M NO2 level-2 product (plume mapping)**

- EUM NO2 level-2 study algorithm: TriOpSys/KNMI

**CO2M SIF and Aerosol level-2 product**

- EUM SIF level-2 study algorithm: U. Leicester
- EUM Aerosol level-2 study algorithms: GRASP (GRASP-SAS/U. Lille)

**CO2M Products requirements:**

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Noel et al., AMT 2021