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| | | Version 1.0 |
| | | 15/03/2024 |
| OLLGHGs INVENTORY (URD) | | |

LOng-Lived greenhouse gas PrOducts Performances (LOLIPOP)

Inventory of OLLGHGs satellite products

Annex to URD (D 1.1)

| | |
|--------------------|---|
| Document Reference | <i>[D1.1] LOLIPOP_URD</i> |
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| Document Approvers | S. Pinnock (ESA, Technical Officer) |

Change log:

| Version Nr. | Date | Status | Reason for change |
|--------------------|--------------------|------------------------|--------------------------|
| <i>Version 1</i> | <i>15-Mar-2024</i> | <i>Initial version</i> | |



**OLLGHGs INVENTORY
(URD)**

[D1.1] LOLIPOP_URD

Version 1.0

15/03/2024

**OLLGHG_s INVENTORY
(URD)**

[D1.1] LOLIPOP_URD

Version 1.0

15/03/2024

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| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF₄</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

1 Introduction

This document is the ANNEX 2 of the Delivery D1.1 "User Requirements Analysis and Inventory of Satellite Products - (URD)".

This document was edited with the contribution of

| | |
|--|----------------|
| Gabriele Stiller, Michael Kiefer for MIPAS-KIT | (KIT) |
| Kaley Walker, Laura Saunders for ACE-FT | (UoT) |
| Bart Dils for IASI-NOPIR | (BIRA) |
| Pierre Coheur for IASI-CFCs | (ULB) |
| Brice Barret for IASI-SOFRID | (Uni-Toulouse) |
| Stefan Noel for TANSO-FTS | (Univ. Bremen) |
| Jean-Luc Attié for IASI-TN2OR | (Uni-Toulouse) |
| T. Sugita for ILAS II | (NIES) |
| R. Spang for CRISTA | (Julich FZC) |

1.1 Structure of the document

The document is arranged in 11 main sections corresponding to the greenhouse gases summarized in the inventory: the Nitrous Oxide (N₂O), the Chlorofluorocarbons (CFC-11, CFC-12, CFC-113 and CF₄), the Hydrofluorocarbons (HFC-23, HFC-134a); the Hydrochlorofluorocarbons (HCFC-22, HCFC-142b), the Sulfur Hexafluoride (SF₆) and the Carbon Tetrachloride (CCl₄). Each section contains the inventory of the available datasets identified by the corresponding instrument used for the observations. For some instruments different algorithms have been used for processing the measurements and the corresponding datasets are described in the document.

A button selector located at the top of each page allows the navigation between the sections of the document and, for each section, between the instruments.

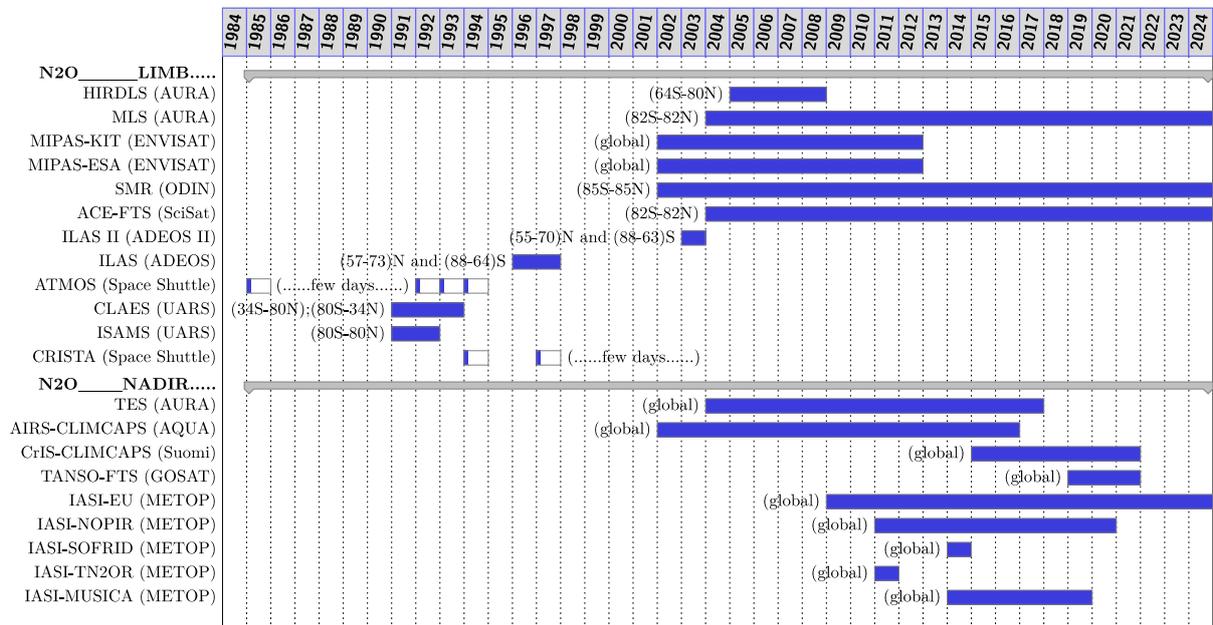
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| N2O | CFC | | | HCFC | | HFC | | CCI4 | SF6 |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

1.2 Acronyms and Abbreviations

| Abbreviation | Meaning |
|--------------|---|
| ACE-FTS | The Atmospheric Chemistry Experiment Fourier Transform Spectrometer |
| AIRS | Atmospheric Microwave Sounding Unit |
| AMSU | Atmospheric Microwave Sounding Unit |
| ATMOS | Atmospheric Trace Molecule Spectroscopy |
| BADC | the British Atmospheric Data Centre |
| CLAES | Cryogenic Limb Array Etalon Spectrometer |
| CLIMCAPS | Community Long-term Infrared Microwave Coupled Product System |
| CrIS | Cross-track Infrared Sounder |
| CRISTA | CRyogenic Infrared Spectrometers and Telescopes for the Atmosphere |
| FTS | Fourier Transform Spectrometer |
| GEOS5 | Goddard Earth Observing System Model, Version 5 |
| GES DISC | Goddard Earth Sciences Data and Information Services Center |
| HDF-EOS5 | Hierarchical Data Format for the Earth Observing System |
| HIRDLS | High Resolution Dynamics Limb Sounder |
| IASI | (Infrared Atmospheric Sounding Interferometer) |
| ILAS | Improved Limb Atmospheric Spectrometer |
| ISAMS | The Improved Stratospheric and Mesospheric Sounder |
| MIPAS | Michelson Interferometer for Passive Atmospheric Sounding |
| MLS | Microwave Limb Sounder |
| EOS-MLS | Earth Observing System - Microwave Limb Sounder |
| NetCDF | Network Common Data Form |
| SMR | Sub-Millimetre Radiometer |
| TANSO-FTS | Thermal And Near infrared Sensor for carbon Observation - FTS |
| TES | Tropospheric Emission Spectrometer |
| ACE-FTS | The Atmospheric Chemistry Experiment Fourier Transform Spectrometer |
| AIRS | Atmospheric Microwave Sounding Unit |
| AMSU | Atmospheric Microwave Sounding Unit |

2 The Nitrous Oxide (N2O)

| INSTRUMENT SELECTOR | | | |
|---------------------|-------------------------------|---------------------------------|------------------------------|
| <i>LIMB</i> | HIRDLS | MLS | MIPAS-KIT |
| | MIPAS-ESA | SMR | ACE-FTS |
| | ILAS II | ILAS | ATMOS |
| | CLAES | ISAMS | CRISTA |
| <i>NADIR</i> | TES | AIRS | CrIS |
| | TANSO-FTS | IASI (EUMETSAT) | IASI (NOPIR) |
| | IASI (SOFRID) | IASI (TN2OR) | IASI-MUSICA |



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| | | | | | | | 15/03/2024 | | |
| N₂O | CFC | | | HCFC | | HFC | | CCI4 | SF₆ |
| | 11 | 12 | 113 | CF₄ | 22 | 142b | 23 | 134a | |

2.1 HIRDLS/AURA

| HIRDLS N ₂ O products | |
|----------------------------------|---|
| <i>Product type</i> | VMR profile |
| <i>Level 2 processor</i> | |
| <i>Data version</i> | L2 V7 |
| <i>Reference</i> | https://docserver.gesdisc.eosdis.nasa.gov/repository/Mission/HIRDLS/3.3_Product_Documentation/3.3.5_Product_Quality/HIRDLS-DQD_V7.pdf |
| <i>Geometry</i> | limb |
| <i>Temporal coverage</i> | January 29, 2005 - March 17, 2008. |
| <i>Spatial coverage</i> | +80 to -64 degrees latitude |
| <i>Spatial resolution</i> | 300 km x 10 km |
| <i>Vertical resolution</i> | 1-1.2 km |
| <i>Useful vertical range</i> | 100-5.1 hPa |
| <i>Spectroscopic database</i> | |
| <i>Spectral range</i> | 21 channels ranging from 6.12 to 17.76 microns: for N ₂ O channel centered at 1270 cm ⁻¹ over the P branch of the v1 transition |
| <i>Product characterization</i> | Estimated precision |
| <i>Data Format</i> | HDF-EOS5 |
| <i>Contact</i> | Rashid Khosravi |
| <i>Data download</i> | https://disc.gsfc.nasa.gov/datasets/HIRDLS2_007/summary?keywords=HIRDLS |
| <i>Recommendation</i> | Use zonal means, Estimated accuracy for zonal means: +/- 10 |

THE INSTRUMENT

Short description in section [INSTRUMENTS → HIRDLS short description](#)

DATA OVERVIEW

The "HIRDLS/Aura Level 2 Geophysical Parameters" data product (HIRDLS2) contains an entire day's worth of Level-2 vertical profiles of O₃, HNO₃, H₂O, CFC-11, CFC-12, N₂O, NO₂, N₂O₅, ClONO₂, temperature, geopotential height, and aerosol extinction at 12.1 and 8.3 microns, as well as cloud top pressure.

CONCLUSIONS AND VALIDATION

These data are unique in having a vertical resolution of ~ 1 km, and frequently the ability to sound down into the upper troposphere.

Observations of the Earth's atmosphere were only made from the far azimuth scan (away from sun side) resulting in limited data coverage from +80 to -64 degrees latitude. The useful

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| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

vertical range of the data depends on the measured species, and are provided on 24 levels per decade of pressure corresponding to about 1 km vertical resolution.

The aperture obscuration makes it difficult to calculate accuracy based on error propagation. Therefore, HIRDLS N₂O accuracy is assessed by comparing the retrieved data with correlative measurements of MLS v3.3 data, collocated to HIRDLS tangent heights. Representative version 7 HIRDLS N₂O profile data show vertical resolution of 1-1.2 km and standard deviation of 15-40% (precision/VMR) between 12-35 km altitude range. Profile data also exhibit jaggedness and large biases relative to MLS v3.3 data that vary significantly with altitude, latitude, day of year, and orbit during the day. Because of the jaggedness and large variation with latitude, time, and orbit, it is difficult to assign an accuracy estimate to HIRDLS N₂O profile data. However, HIRDLS N₂O monthly and zonal mean data are much smoother and show significantly better agreement with MLS data. As seen in the right most panels, the HIRDLS monthly and zonal mean data are within $\pm 10\%$ of MLS data in the 100-5 hPa pressure range for most latitudes, although larger biases can occur at mid-and high latitudes; e.g. in March and Sep. At altitudes above 5 hPa, the zonal mean data show consistent negative bias of 40% or more. However, because of low signal-to-noise ratio at these altitudes, the a priori contribution is high and care must be taken to assess the quality and usefulness of the data by screening for negative precision. However, HIRDLS monthly zonal mean v7 N₂O data compare well with MLS data, and may thus be useful for scientific applications in the 100-5 hPa pressure range.

FILTERING AND DATA QUALITY

Data points for which most of the information comes from the a priori have their precision fields set negative, and the user should decide whether data are suitable for scientific studies.

See Khosravi et al., [2009a,b]; <http://www.agu.org/journals/jd/jd0920/2009JD011937/> for details on quantitative a priori contributions to the errors. In addition, one may consult the document "Description of HIRDLS Predicted Precision Data", available from the web page <http://www.eos.ucar.edu/hirdls/data> for details on negative precision.

HIRDLS data processing makes use of some Microwave Limb Sounder (MLS) data for contaminants. Because of the lack of full days of MLS data for 29 March-4 April (days 88-94) 2006, HIRDLS processing used data from NCAR's Whole Atmosphere Community Climate Model (WACCM), driven by the GEOS5 meteorological data. These data are denoted by version v07-00-10, but are included as part of the V7 time series. Although no anomalies in these data have been noticed, users should be aware of this.

DATA AVAILABILITY

The data are stored in the version 5 Hierarchical Data Format for the Earth Observing System (HDF-EOS5), which is an extension of the HDF5 format. Each file contains a single swath object with one day of data (measured species and species precision), geolocation fields (e.g. time, latitude, longitude, pressure), and swath attributes, along with file level metadata. Each file contains approximately 5600 profile scans.

HIRDLS data are available from several worldwide data repositories. In the United States, HIRDLS data can be downloaded from the Goddard Earth Sciences Data and Information Services Center (GES DISC) (<http://disc.sci.gsfc.nasa.gov/data-holdings>). HIRDLS data are also available in the United Kingdom and Europe from the British Atmospheric Data Centre (BADC) (<http://badc.nerc.ac.uk/browse/badc/hirdls>). In both institutions, several versions of HIRDLS data are available and care should be taken to make sure that V7 data is requested.

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| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

HIRDLS data are stored in the HDF-EOS5 format in the HDF-EOS Aura File Format Guidelines

"https://docserver.gesdisc.eosdis.nasa.gov/repository/Mission/HIRDLS/3.3_Product_Documentation/3.3.5_Product_Quality/HIRDLS-DQD_V6.pdf"

Licence: <http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/>

Also Level 3 Data Products available at:

https://disc.gsfc.nasa.gov/datasets/H3ZFCN2O_007/summary?keywords=L3%20HIRDLS

For the gridded data provided here results are generated every 1° of longitude, to create a 1° x 1° grid.

There are two time fields in the HIRDLS Level 2 data file, Time and SecondsInDay. Time is stored in TAI time (seconds since the epoch of 00.00 UTC 1-1-1993). This time includes leap seconds and can cause problems with simplistic conversions. For this reason, HIRDLS is also storing SecondsInDay which is seconds since midnight of the data day.

Leap seconds do not pose a problem when using this field. Note that the first data point may be negative which indicates a time stamp before midnight. This is the case for scans that span a day boundary.

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| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

2.2 MLS/AURA

| MLS N ₂ O products | |
|---------------------------------|---|
| <i>Product type</i> | VMR profile |
| <i>Level 2 processor</i> | |
| <i>Data version</i> | L2 V5 |
| <i>Reference</i> | Sect. 3.17 of https://mls.jpl.nasa.gov/data/v5-0_data_quality_document.pdf |
| <i>Geometry</i> | Limb |
| <i>Temporal coverage</i> | 2004-nowadays |
| <i>Spatial coverage</i> | -82 degrees to +82 degrees latitude, with each profile spaced 1.5 degrees or ~165 km along the orbit track (roughly 15 orbits per day) |
| <i>Spatial resolution</i> | Horizontal along-track resolution is 165-260 km for N ₂ O-NitrousOxide, 330-600 km for N ₂ O-640 |
| <i>Vertical resolution</i> | 5-8 km for N ₂ O-NitrousOxide, 4-6 km for N ₂ O-640 |
| <i>Useful vertical range</i> | N ₂ O-640: 100–0.46 hPa |
| <i>Spectroscopic database</i> | |
| <i>Spectral range</i> | <p>The standard product for v5.0x N₂O is taken from the MLS "band 3" 190-GHz radiances (retrieved in the NitrousOxide phase) in order to provide a continuous data product (N₂O-NitrousOxide) from launch.</p> <p>[Previous versions relied on the "band 12" 640-GHz (CorePlusR4B) retrieval, however, a noticeable reduction in quality of the band 12 radiance signals became evident during June-August 2013. Band 12 was finally turned off on August 6, 2013, and the data collected on and after 7 June 2013 for N₂O-640 are not recommended for scientific use.]</p> |
| <i>Product characterization</i> | <p>The estimated precision on a single retrieved profile varies with height from ~12–18 ppbv for N₂O-NitrousOxide and ~12–25 ppbv for N₂O-640.</p> <p>A priori profile available. AK not available</p> |
| <i>Data Format</i> | HDF-EOS5 |
| <i>Contact</i> | |
| <i>Data download</i> | https://disc.gsfc.nasa.gov/datasets/ML2N2O_005/summary?keywords=MLS%20N2O |
| <i>Recommendation</i> | <p>There is also a secondary product v5.0x N₂O 640-GHz product available for the period from launch until June 6, 2013 and stored in the L2GP-DGG files in the N₂O-640 swath.</p> <p>Users retrieving data from the GESDISC DATA ARCHIVE agree to adhere to the NASA GES DISC Data Policy at https://disc.gsfc.nasa.gov/information/documents?title=data-policy</p> |

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| N₂O | CFC | | | HCFC | | HFC | | CCl₄ | SF₆ |
| | 11 | 12 | 113 | CF₄ | 22 | 142b | 23 | 134a | |

Short description in section [INSTRUMENTS → EOS MLS short description](#)

DATA OVERVIEW

ML2N2O is the EOS Aura Microwave Limb Sounder (MLS) standard product for nitrous oxide derived from radiances measured primarily by the 640 GHz radiometer (Band 12) until August 6, 2013, after this date using the 190 GHz radiometer (Band 3).

The data are stored in the version 5 EOS Hierarchical Data Format (HDF-EOS5), which is based on the version 5 Hierarchical Data Format, or HDF5. Each file contains two swath objects (profile and column data), each with a set of data and geolocation fields, swath attributes, and metadata.

CONCLUSIONS AND VALIDATION

Average values for v5.0x 190-GHz N₂O are substantially smaller and more realistic than in previous versions for the 100 and 68 hPa pressure levels. For pressures smaller than 68 hPa (i.e., at altitudes higher than this pressure surface) differences are within a few percent.

Average values for v5.0x 640-GHz N₂O are 20% larger than in v2.2 for the 100 hPa pressure level, up to 10% smaller at the 46–32 hPa levels, and within 5% for pressures greater than 22 hPa. Differences between v5.0x 640-GHz N₂O and v4.2x are less than 10% at all levels.

Apart from the differences noted above, the MLS v5.0x 640 GHz N₂O is similar to the MLS v2.2 product described and validated in Lambert et al. [2007]. Comparisons of v2.2 640 GHz N₂O with coincident measurements by ACE-FTS, Odin/SMR, and Envisat/MIPAS and balloon borne observations are shown in Lambert et al. [2007]. A revised validation paper for N₂O is not planned and users are encouraged to read Lambert et al. [2007] for more information. Lambert, A., et al., Validation of the Aura Microwave Limb Sounder stratospheric water vapor and nitrous oxide measurements, J. Geophys. Res., 112(D24), D24S36, doi: 10.1029/2007JD008724, 2007.

The 190-GHz N₂O data product in general shows slightly worse precision and resolution compared to the 640-GHz retrievals, although the 190-GHz precision is substantially better at 100–68 hPa. Data from N₂O-NitrousOxide and N₂O-640 have been compared from launch until the end of band 12 operations. A persistent low bias over the pressure range 46 to 22 hPa peaking at –15% is seen in the N₂O-NitrousOxide product compared to N₂O-640. The biases are generally smaller than 5% from 100 to 68 hPa and 10% from 15 to 4.5 hPa.

FILTERING AND DATA QUALITY

Estimated precision: only use values for which the estimated precision is a positive number. Values where the a priori information has a strong influence are flagged with negative or zero precision, and should not be used in scientific analyses.

Status flag: only use profiles for which the Status field is an even number. Odd values of Status indicate that the profile should not be used in scientific studies.

Clouds: clouds have little impact on the N₂O products at the recommended pressure levels. Ignore status bit 16 (high cloud) or bit 32 (low cloud) indicating the presence of clouds.

Useful range: pressure range: 100–0.46 hPa

Quality: only profiles whose Quality field is greater than 0.8 should be used. A small fraction of N₂O-NitrousOxide profiles (typically less than 1.5%) will be discarded via this screening.

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|---|---|-----------|------------|-----------------------|-------------|-------------|------------|--------------------|------------------------|-----------------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 13 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| <u>N₂O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCl₄</u> | <u>SF₆</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF₄</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

Convergence: only profiles whose Convergence field is less than 2.0 should be used. A fraction of the N₂O-NitrousOxide data (typically less than 0.5%) at this level will be discarded via this screening.

For N₂O-640: Pressure range 100–0.46 hPa

Quality (N₂O-640): Only profiles whose Quality field is greater than 1.4 should be used. A small fraction of N₂O-640 profiles (typically less than 1.5%) will be discarded via this screening.

Convergence (N₂O-640): Only profiles whose Convergence field is less than 1.01 should be used. A fraction of the N₂O-640 data (typically less than 0.5%) at this level will be discarded via this screening.]

DATA AVAILABILITY

Users retrieving data from the GESDISC DATA ARCHIVE agree to adhere to the NASA GES DISC Data Policy at <https://disc.gsfc.nasa.gov/information/documents?title=data-policy>

| | | | | | | | | | |
|---|---|-----------|------------|-----------------------|-----------|-------------|--------------------|------------------------|-----------------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 14 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N₂O | CFC | | | HCFC | | HFC | | CCl₄ | SF₆ |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF₄</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

2.3 MIPAS-KIT/ENVISAT

| MIPAS-KIT N ₂ O products | |
|-------------------------------------|---|
| <i>Product type</i> | VMR profile |
| <i>Level 2 processor</i> | IMK-IAA |
| <i>Data version</i> | L1b V8 L2 2002-2004: N2O_61 (NOM) 2005-2012: N2O_161 (UTLS1), N2O_261 (NOM), N2O_561 (MA) 2005-2012: N2O_562 (MA), N2O_662 (UA), N2O_762 (NLC) |
| <i>Reference</i> | https://doi.org/10.5194/egusphere-2023-919 |
| <i>Geometry</i> | limb |
| <i>Temporal coverage</i> | 2002-2012 |
| <i>Spatial coverage</i> | global |
| <i>Spatial resolution</i> | |
| <i>Vertical resolution</i> | 3-4 km in stratosphere, 4-6 km above |
| <i>Horizontal resolution</i> | 300-500 km below 45 km, 500-700 km above |
| <i>Useful vertical range</i> | 5-70 km |
| <i>Spectroscopic database</i> | HITRAN 2016 |
| <i>Spectral range</i> | Microwindows in 1217-1338 cm ⁻¹ |
| <i>Product characterization</i> | Random error, Systematic error, Vert. Resolution, DOFs |
| <i>Data Format</i> | NetCDF |
| <i>Contact</i> | Gabi Stiller |
| <i>Data download</i> | https://www.imk-asf.kit.edu/english/308.php |
| <i>Recommendation</i> | |

THE INSTRUMENT

Short description in section [INSTRUMENTS-→ MIPAS short description](#)

DATA OVERVIEW

All Nominal, UTLS-1, Middle Atmosphere, Upper Atmosphere and Noctilucent Cloud observation modes have been processed.

All details in <https://doi.org/10.5194/egusphere-2023-919>

CONCLUSIONS AND VALIDATION/

V5 validated in: <https://doi.org/10.5194/amt-9-765-2016>.

The most relevant changes in the V8 retrieval setup compared to the earlier data versions are related to the selection of microwindows, the spectroscopic data, the regularization, the treatment of horizontal variability and the modelling of the zero offset.

| | | | | | | | | | | |
|---|---|-----------|------------|-----------------------|-------------|-------------|------------|--------------------|------------------------|-----------------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 15 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| <u>N₂O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCl₄</u> | <u>SF₆</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF₄</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

FILTERING AND DATA QUALITY

For valid data at a given altitude the data set entries 'visibility' and 'akm_diagonal' have to be equal to 1 and greater than 0.03, respectively, at that altitude.

DATA AVAILABILITY

The data are available after registration at IMK-ASF web page (<https://www.imk-asf.kit.edu/english/308.php>)

| | | | | | | | | | |
|---|---|-----------|------------|-----------------------|-----------|-------------|--------------------|-------------|-----------------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 16 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N₂O | CFC | | | HCFC | | HFC | | CCI4 | SF₆ |
| | 11 | 12 | 113 | CF₄ | 22 | 142b | 23 | 134a | |

2.4 MIPAS-ESA/ENVISAT

| MIPAS-ESA N ₂ O products | |
|-------------------------------------|--|
| <i>Product type</i> | VMR profile |
| <i>Level 2 processor</i> | Optimised Retrieval Model |
| <i>Data version</i> | L2 V8.22 |
| <i>Reference</i> | https://doi.org/10.5194/amt-14-7975-2021 ; https://earth.esa.int/eogateway/documents/20142/37627/READ_ME_V8_issue_1.0_20201221.pdf |
| <i>Geometry</i> | Limb |
| <i>Temporal coverage</i> | 2002-2012 |
| <i>Spatial coverage</i> | Global |
| <i>Horizontal resolution</i> | It depends on the meas. modes, around 400-500 km for NOM |
| <i>Vertical resolution</i> | About 4 km up to 30 km, slow degradation with altitude above |
| <i>Useful vertical range</i> | 6-60 km |
| <i>Spectroscopic database</i> | Spectroscopic Database: HITRAN_mipas_pf4.45 is based on HITRAN08 (Rothman et al., 2009), but spectroscopic parameters for the molecules O ₂ , SO ₂ , OCS, CH ₃ Cl, C ₂ H ₂ and C ₂ H ₆ are taken from HITRAN 2012 (Rothman et al., 2012). |
| <i>Spectral range</i> | Microwindows in 1140.725-1291.95 cm ⁻¹ |
| <i>Product characterization</i> | Random error (and CM), systematic error, AK |
| <i>Data Format</i> | NetCDF |
| <i>Contact</i> | Piera Raspollini |
| <i>Data download</i> | https://hm-atmos-ds.eo.esa.int/oads/access/collection/EnvisatMIPASL2PS |
| <i>Recommendation</i> | – |

THE INSTRUMENT

Short description in section [INSTRUMENTS-→ MIPAS short description](#)

DATA OVERVIEW

The MIPAS level2-v8 database, along with the values of tangent pressures, temperatures, and VMR profiles of all the retrieved molecules, includes also some important products that can be used as diagnostic tools to characterise the quality of the reported results. Among them, the averaging kernels, the covariance matrices that map the random measurement noise onto the solution, and a few quality flags. All the products are stored in NetCDF files.

The L2 V8.22 dataset is described in: <https://doi.org/10.5194/amt-14-7975-2021>. The algorithm used for the reprocessing is described in: <https://doi.org/10.5194/amt-15-1871-2022>.

| | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 17 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

CONCLUSIONS AND VALIDATION

Results of the validation with MIPAS balloon in Wetzell et al., 2022:
<https://doi.org/10.5194/amt-15-6669-2022>.

Results of the validation vs ACE-FTS and ground-based measurements reported in the readme file:
https://earth.esa.int/eogateway/documents/20142/37627/README_V8_issue_1.0_20201221.pdf.

The comparison results show a globally (without the Antarctic) and vertically consistent MIPAS N2O V8 bias of about 5 % positive and a similar spread, meaning that median differences are at the edge of being significant. The V8 (and V7) N2O bias is slightly reduced with respect to the V5 and V6 bias results in the full resolution period, yet at the cost of a small bias increase in the optimised resolution period. Note however that the smoothed difference profile shape does not seem to be in agreement with the MIPAS balloon comparisons (also at Kiruna). The large comparison uncertainties moreover make it difficult to detect seasonal dependences or trends. Positive bias for N2O (10 %–20 %) below 35 km (within combined systematic errors); especially N2O pronounced for N2O in the lowermost stratosphere around 15 km. Somewhat larger positive deviations also in the tropics around 30 km.

MIPAS exhibits a significant positive bias of about 5% with respect to the ground-based FTIR measurements. In the comparison to the balloon observation, this positive bias is even more pronounced reaching values typically between 10 and 20%. This holds for both MIPAS observation periods (FR and OR mode) and different geographical regions.

FILTERING AND DATA QUALITY

The quality of the retrieved profiles is determined on the basis of four criteria, two providing information on the successful convergence of the retrieval iterations, one on the capability of the retrieval to reproduce the measurements, and one on the presence of outliers in the retrieval error.

To provide an easy way to remove unreliable data, a final post-quality flag, summarising the outcome of the four quality criteria, is reported in the output files.

Take all profiles with `post_quality_flag=0`.

DATA AVAILABILITY

The data are available after registration at <https://doi.org/10.5270/EN1-c8hgqx4> (European Space Agency, 2021). Their utilisation is subject to ESA's Earth Observation Terms and Conditions.

The information has been divided into two types of files: a standard one and an extended one. The standard files, one for each orbit and retrieved species, contain the information commonly required by the data users. Its filetype label is "2PS", and it is compliant with the Climate and Forecast convention (CF-1.6, Eaton et al., 2011) and with the Attribute Convention for Data Discovery (ACDD-1.3, ESIP, 2015). Extended files, identified by the filetype label "2PE", are also provided for each species and each orbit. They are "thought" for diagnostics and for advanced users, who need complete information about the retrieval process. This includes the full state vector (retrieved profiles, atmospheric continuum, and instrumental offset), along with the full CM and AKM, and additional information about the retrieval.

| | | | | | | | | | |
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|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 18 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N₂O | CFC | | | HCFC | | HFC | | CCI4 | SF₆ |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

2.5 SMR/ODIN

| SMR N ₂ O products | |
|---------------------------------|--|
| <i>Product type</i> | VMR profile |
| <i>Level 2 processor</i> | |
| <i>Data version</i> | V3 |
| <i>Reference</i> | https://odin-smr.org ; https://doi.org/10.1029/2004JD005741 |
| <i>Geometry</i> | limb |
| <i>Temporal coverage</i> | 2002-present days |
| <i>Spatial coverage</i> | +85.2 to -85.2 degrees latitude |
| <i>Spatial resolution</i> | |
| <i>Vertical resolution</i> | 5 km |
| <i>Useful vertical range</i> | 15-50 km |
| <i>Spectroscopic database</i> | |
| <i>Spectral range</i> | 501 GHz (frequency mode 01) |
| <i>Product characterization</i> | <p>Apriori: A priori profile used in the inversion algorithm ([-] or [K]).</p> <p>AVK: Averaging kernel matrix. For gas species, the averaging kernel for relative changes is given ([%/%]).</p> <p>ErrorNoise: Error due to measurement thermal noise (square root of the diagonal elements of the corresponding error matrix) ([-] or [K]).</p> <p>ErrorTotal: Total retrieval error, corresponding to the error due to thermal noise and all interfering smoothing errors (square root of the diagonal elements of the corresponding error matrix) ([-] or [K]).</p> |
| <i>Data Format</i> | NetCDF |
| <i>Contact</i> | donal.murtagh@chalmers.se |
| <i>Data download</i> | <p>Available both:</p> <p>Odin-SMR Level 2 (https://doi.org/10.5270/OD1-d98abd8) as NetCDF files;</p> <p>Odin-SMR monthly Level 2 (https://doi.org/10.5270/OD1-34d7e73) as NetCDF files derived from L2 v3.0 data.</p> |
| <i>Recommendation</i> | – |

THE INSTRUMENT

Short description in section [INSTRUMENTS](#)→ [SMR short description](#)

DATA OVERVIEW

| | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 19 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N2O | CFC | | | | HCFC | | HFC | CCI4 | SF6 |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

CONCLUSIONS AND VALIDATION/

See <https://odin-smr.org/static/documents/PVER.pdf>, Sect 3.1.2.2.

The retrievals for N2O have been compared with data from the MIPAS-KIT and MLS instruments. Annual average differences to these instruments are within 10% wrt MIPAS-KIT, are within 20% wrt MLS. The product is useful over the range 15–50 km with a vertical resolution of around 5 km.

FILTERING AND DATA QUALITY

https://odin-smr.org/static/documents/L2_DATA.pdf

The monthly L2 product files are quality filtered, and contain only "valid" data.

DATA AVAILABILITY

L2 data can be obtained in two ways:

1. via a web-api that can be queried and used to get data from a specified area and time interval or from specific scans etc. Documentation about the web-api is found here:
 - <http://odin.rss.chalmers.se/apidocs/index.html>;
 - <http://odin.rss.chalmers.se/dataaccess>.

The L2 part of the Odin web-api contains a number of endpoints (<http://odin.rss.chalmers.se/apidocs/index.html#/level2>), that provides three different L2 data objects denoted as L2, L2i, and L2anc. The L2 object contains the main result of the retrieval calculation (e.g. retrieved profile and averaging kernels), the L2i object contains obtained offsets and residual etc. from the retrieval calculation, and the L2anc object contains ancillary data.

The endpoints provide the L2 data in JSON format.

2. or through downloading monthly L2 product files over http from a file archive (http://odin.rss.chalmers.se/level2_download/). This option can preferably be used if all or a large part of the Odin data is of interest.

The monthly L2 product files have a netCDF format.

Monthly data: Each L2 product file contains retrieved VMR or temperature profiles, where a single profile is associated with a single scan of the atmosphere by the Odin/SMR instrument. The L2 product files covers one month of data, but all retrieved data for this month is not necessarily included, as the data is filtered.

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|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 20 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| <u>N₂O</u> | <u>CFC</u> | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF₆</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF₄</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

2.6 ACE-FTS/SciSat

| ACE-FTS N ₂ O products | |
|-----------------------------------|--|
| <i>Product type</i> | VMR profile |
| <i>Level 2 processor</i> | |
| <i>Data version</i> | v5.2 |
| <i>Reference</i> | https://doi.org/10.1016/j.jqsrt.2023.108749 |
| <i>Geometry</i> | Limb |
| <i>Temporal coverage</i> | February 2004 - present |
| <i>Spatial coverage</i> | 82 N – 82 S |
| <i>Spatial resolution</i> | |
| <i>Vertical resolution</i> | ~3 km (based on FOV of instrument), 1.5-6 km sampling |
| <i>Useful vertical range</i> | 5 – 95 km |
| <i>Spectroscopic database</i> | HITRAN 2020 |
| <i>Spectral range</i> | Microwindows in 1134-1278 cm ⁻¹ and 2199-2237 cm ⁻¹ |
| <i>Product characterization</i> | Precision estimate provided at each altitude in profile |
| <i>Data Format</i> | netCDF |
| <i>Contact</i> | Kaley Walker |
| <i>Data download</i> | ACE-FTS data can be accessed at the following web portal: https://databace.scisat.ca/level2/ace_v5.2/display_data.php . First time data users can register at: https://databace.scisat.ca/l2signup.php Data quality flags provided separately at: https://doi.org/10.5683/SP3/NAYNFE |
| <i>Recommendation</i> | – |

THE INSTRUMENT

Short description in section [INSTRUMENTS → ACE-FTS short description](#)

DATA OVERVIEW

The details of the current ACE-FTS processing version are in Boone et al. (2003) <https://doi.org/10.1016/j.jqsrt.2023.108749>.

CONCLUSIONS AND VALIDATION/

V2.2+updates was validated by Strong et al. (2008) <https://doi.org/10.5194/acp-8-4759-2008>; V3.5 was validated by Sheese et al. (2017) <http://dx.doi.org/10.1016/j.jqsrt.2016.06.026>; v4.1/4.2 has a slight high bias, within 10%, between 20 and 30 km and has even better agreement of -3% to 5% outside of this range. Work on v5.2 is on-going.

FILTERING AND DATA QUALITY

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 21 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

Data quality flags are provided for ACE-FTS v5.2 at <https://doi.org/10.5683/SP3/NAYNFE> based on the methodology described in Sheese et al. (2015) <https://doi.org/10.5194/amt-8-741-2015>

It is recommended to use data where flag = 0; profiles that include a flag value of 4 or 5 can also be filtered out, except when data set contains realistic sporadic enhancements. Always look at rejected data to ensure that physically realistic data are not being filtered out. Some datasets will require further filtering.

DATA AVAILABILITY

Available online (https://database.scisat.ca/level2/ace_v5.2/display_data.php).

Access to Level 2 data after registration.

| | | | | | | | | | |
|---|---|-----------|------------|-----------------------|-------------|-------------|--------------------|------------------------|-----------------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 22 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N₂O | CFC | | | | HCFC | | HFC | CCl₄ | SF₆ |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF₄</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

2.7 ILAS II/ADEOS II

| | |
|--|--|
| ILAS-II N₂O products | |
| <i>Product type</i> | VMR profiles |
| <i>Level 2 processor</i> | |
| <i>Data version</i> | V3.0 |
| <i>Reference</i> | |
| <i>Geometry</i> | Limb |
| <i>Temporal coverage</i> | Jan 2003-Oct 2003 (1 profile per ~100 min in each hemisphere) |
| <i>Spatial coverage</i> | 56-70 °N and 63-88 °S |
| <i>Spatial resolution</i> | The instantaneous field of view at the tangent height (TH) has a 1 km height in the vertical direction and a 13 km width in the horizontal direction for the infrared channel. Latitude: Depends on season Longitude: ~25 degrees Vertical: 1.3-2.9 km at tangent heights of 15-55 km |
| <i>Vertical sampling</i> | 1 km between 5 and 60 km |
| <i>Useful vertical range</i> | |
| <i>Spectroscopic database</i> | HITRAN 2004 |
| <i>Spectral range</i> | 6.2–11.8 μm with 44 spectral elements |
| <i>Product characterization</i> | Error (internal and total error as described in Sect.6 of https://doi.org/10.1029/2001JD000628) |
| <i>Data Format</i> | Ascii NASA Ames Format 2160 https://espoarchive.nasa.gov/content/Ames_Format_Specificat ion_v20 |
| <i>Contact</i> | tsugita@nies.go.jp |
| <i>Data download</i> | https://db.cger.nies.go.jp/DL/10.17595/20180628.004.html.en |
| <i>Recommendation</i> | |

THE INSTRUMENT

Short description in section [INSTRUMENTS-→ ILAS II short description](#)

DATA OVERVIEW

CONCLUSIONS AND VALIDATION/

No validation papers for V3. V2 was validated with MIPAS:

<https://acp.copernicus.org/articles/8/825/2008/acp-8-825-2008.pdf>

FILTERING AND DATA QUALITY

| | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 23 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

Data quality: GOOD in the product files means that all of the 44 spectral channels are in good condition. To select only data characterised by: 'Data quality: GOOD'.

DATA AVAILABILITY

In the web page <https://db.cger.nies.go.jp/DL/10.17595/20180628.004.html.en> it is possible to download separately two tar.gz files for the Sunrise and the Sunset measurements. When untaring there are 2 directories: V03.00 and V03.01

v3.01 is just acquired by AC (alternating current) mode, v3.00 is DC mode, with AC and DC being the two different mode data acquisitions (Nakajima et al., 2006). Since there is no difference between the data products as measured exclusively with the two modes, it is seamless to handle both of the branch numbers in data versions , e.g., 3.00 (DC mode) and 3.01 (AC mode).

Please refer Yokota's unpublished v1.4 draft paper from:
<https://www.nies.go.jp/doi/10.17595/20180628.004-e.html>

ACKNOWLEDGEMENTS.

Licence: CC BY 4.0 (Creative Commons Attribution 4.0 International)

Citation format: When this data set is referred to in publications, it should be cited in the following format.

Sugita, T., H. Nakajima, and T. Yokota (2018), Improved Limb Atmospheric Spectrometer-II (ILAS-II), Version 3.0, Center for Global Environmental Research, NIES, DOI:10.17595/20180628.004. (Reference date*: YYYY/MM/DD)

As the reference date, please indicate the date you downloaded the files.

| | | | | | | | | | |
|---|---|-----------|------------|-----------------------|-----------|-------------|--------------------|-------------|-----------------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 24 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N₂O | CFC | | | HCFC | | HFC | | CCI4 | SF₆ |
| | 11 | 12 | 113 | CF₄ | 22 | 142b | 23 | 134a | |

2.8 ILAS/ADEOS

| ILAS N ₂ O products | |
|---------------------------------|--|
| <i>Product type</i> | VMR profiles |
| <i>Level 2 processor</i> | onion-peeling method and nonlinear least squares fitting |
| <i>Data version</i> | V06.10 |
| <i>Reference</i> | https://db.cger.nies.go.jp/ilas_pub/reference/Sugita_2005_ILAS_v6_tech_report.pdf https://db.cger.nies.go.jp/MD/10.17595/20180628.001.html.en |
| <i>Geometry</i> | Limb |
| <i>Temporal coverage</i> | 18.09.1996-29.06.1997 (reprocessed on 21.10.2005) |
| <i>Product type</i> | VMR profiles |
| <i>Spatial resolution</i> | Northern Hemisphere] Latitude: 57° ~ 73°, Longitude: -180° ~ 180°; [Southern Hemisphere] Latitude: -64° ~ -88°, Longitude: -180° ~ 180° |
| <i>Vertical resolution</i> | Vertical: 1.9-3.5 km at tangent heights of 15-55 km |
| <i>Useful vertical range</i> | Vertical: ~10 km - 70 km |
| <i>Spectral range</i> | an infrared spectrometer (between 6.21 μm to 11.77 μm) and a visible spectrometer (between 753 nm and 784 nm). |
| <i>Product characterization</i> | Error (internal and total error as described in Sect.6 of: https://doi.org/10.1029/2001JD000628) |
| <i>Data Format</i> | Ascii NASA Ames Format 2160 https://espoarchive.nasa.gov/content/Ames_Format_Specification_v20 |
| <i>Contact</i> | tsugita@nies.go.jp |
| <i>Data download</i> | https://db.cger.nies.go.jp/DL/10.17595/20180628.001.html.en |
| <i>Recommendation</i> | |

THE INSTRUMENT

Short description in section [INSTRUMENTS → ILAS short description](#)

DATA OVERVIEW

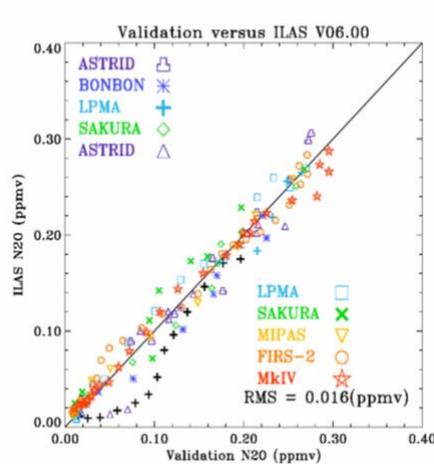
CONCLUSIONS AND VALIDATION/

The vertical profiles of N₂O by the Version 5.20 data processing algorithm were well validated [Sasano, 2002 (doi:10.1029/2002JD002155); and references therein]. In the report https://db.cger.nies.go.jp/ilas_pub/reference/Sugita_2005_ILAS_v6_tech_report.pdf, the products of Version 6 algorithm were again compared with its correlative data from balloon-borne measurements and coincident data from satellite-borne measurements and the quantitative difference between the two data set in each of the chemical species was also evaluated. For N₂O, the differences range from -12% to 0% for altitudes between 11 and 30 km.

| | | | | | | | | | | |
|---|---|-----------|------------|-----------------------|--------------------|-------------|------------|-------------|------------------------|-----------------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) OLLGHGs INVENTORY (URD) | | | | Page 25 | | | | | |
| | | | | | [D1.1] LOLIPOP_URD | | | | | |
| | | | | | Version 1.0 | | | | | |
| | | | | | 15/03/2024 | | | | | |
| <u>N₂O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCl₄</u> | <u>SF₆</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF₄</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

The quality of the Version 6 data set is generally comparable to that of the former Version 5.20. The Version 6 ILAS data set includes more scenes (roughly 300) and covers lower detectable altitudes (down to 7 km) compared to the Version 5.20 data set. In total, the Version 6 data set has about 6100 measurement scenes. Data shown as black pluses indicate that the relative difference in PV values for each of the measured air masses at each altitude exceed 15%. Generally, ILAS and its coincident balloon-borne sensors are well correlated each other, except for these black pluses. The root mean square difference from the one by one line is as small as 0.021 ppmv.

Figure 9



FILTERING

Data quality: GOOD in the product files means that all of the 44 spectral channels are in good condition. To select only data characterised by: 'Data quality: GOOD'.

DATA AVAILABILITY

In the web page <https://db.cger.nies.go.jp/DL/10.17595/20180628.004.html.en> it is possible to download one tar.gz file for each trace species which include both the Sunrise and the Sunset measurements. When untaring there is one file for each retrieved profile, relative either to sunset or sunrise, as indicated in the name of the file,

ACKNOWLEDGEMENTS.

When this data set is referred to in publications, it should be cited in the following format:
 Sugita, T., H. Nakajima, and T. Yokota (2018), Improved Limb Atmospheric Spectrometer (ILAS), Version 6.1, Center for Global Environmental Research, NIES, [DOI:10.17595/20180628.001](https://doi.org/10.17595/20180628.001). (Reference date*: YYYY/MM/DD). * As the reference date, please indicate the date you downloaded the files.

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|--------------------|-------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 26 | | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | | |
| | | | | | | | Version 1.0 | | | |
| | | | 15/03/2024 | | | | | | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

2.9 ATMOS/Space Shuttle

7 of the trace species retrieved from ATMOS measurements are of interest for LOLIPOP, namely N2O, CF4, CCI4, SF6, CCI3F (CFC-11), CCI2F2 (CFC-12) and CHF2Cl (HCFC-22).

| ATMOS products | |
|---------------------------------|--|
| <i>Product type</i> | Profiles |
| <i>Level 2 processor</i> | Global fit algorithm: Irion et al., "Atmospheric Trace Molecule Spectroscopy (ATMOS) Experiment Version 3 data retrievals," Applied Optics, Vol. 41, No. 33, 6968–6979, 20 November 2002 |
| <i>Data version</i> | V3 |
| <i>Reference</i> | https://acdisc.gesdisc.eosdis.nasa.gov/data/ATMOS/ATMOSL2AF.3/doc/README.ATMOS_V3.pdf |
| <i>Geometry</i> | Limb |
| <i>Temporal coverage</i> | STS-51B/Spacelab 3 (April 30 to May 1, 1985), STS-45/ATLAS-1 (March 25 to April 2, 1992), STS-55/ATLAS-2 (April 8 to 16, 1993), and STS-66/ATLAS-3 (November 3 to 12, 1994). |
| <i>Spatial coverage</i> | -180.0,-73.0,180.0,75.0 |
| <i>Spatial resolution</i> | 2 km x 2 km |
| <i>Vertical resolution</i> | 1 km |
| <i>Useful vertical range</i> | 5-96 km |
| <i>Spectral range</i> | 600-4800 cm ⁻¹ over several bandpass filters |
| <i>Product characterization</i> | Random error profile, accuracy in Irion et al., "Atmospheric Trace Molecule Spectroscopy (ATMOS) Experiment Version 3 data retrievals," Applied Optics, Vol. 41, No. 33, 6968–6979, 20 November 2002 |
| <i>Data Format</i> | Ascii (see Data availability Section for further information) |
| <i>Contact</i> | Name: GES DISC Help Desk URL: https://disc.gsfc.nasa.gov Email: gsfc-dl-help-disc@mail.nasa.gov |
| <i>Data download</i> | One of the following links, according to the chosen grid and format (see data availability section): https://disc.gsfc.nasa.gov/datasets/ATMOSL2AF_3/summary?keywords=ATMOS%20N2O https://disc.gsfc.nasa.gov/datasets/ATMOSL2AT_3/summary?keywords=ATMOS%20N2O https://disc.gsfc.nasa.gov/datasets/ATMOSL2PT_3/summary?keywords=ATMOS%20N2O https://disc.gsfc.nasa.gov/datasets/ATMOSL2PF_3/summary?keywords=ATMOSL2PF_3 https://disc.gsfc.nasa.gov/datasets/ATMOSL2TF_3/summary?keywords=ATMOSL2TF_3 https://disc.gsfc.nasa.gov/datasets/ATMOSL2TF_3/summary?keywords=ATMOSL2TT_3 |

| | | | | | | | | | |
|---|---|-----------|------------|-----------------------|-----------|-------------|--------------------|-------------|-----------------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 27 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | 15/03/2024 | | | | | | |
| N₂O | CFC | | | HCFC | | HFC | | CCI4 | SF₆ |
| | 11 | 12 | 113 | CF₄ | 22 | 142b | 23 | 134a | |

| | |
|-------------------------------|--|
| <i>Spectroscopic database</i> | Brown et al., 1995 Atmospheric Trace Molecule Spectroscopy (ATMOS) linelist, 1996, doi: 10.1364/AO.35.002828 |
|-------------------------------|--|

THE INSTRUMENT

The ATMOS instrument has flown four times on the Space Shuttle from 1985 to 1993 (see Temporal coverage in the Table below).

Short description in section [INSTRUMENTS → ATMOS short description](#)

DATA OVERVIEW

Version 3 Atmospheric Trace Molecule Spectroscopy (ATMOS) Level 2 product containing trace gases either on a vertical pressure or altitude or geopotential grid with data stored in an ASCII table using either a spreadsheet friendly tab delimited format or fixed format. Data files also include time, geolocation and other information. For each type of files, data are written in separate files grouped by mission (sl3, at1, at2 or at3), and occultation type (sunrise or sunset) and number.

Measured species include: H₂O, CO₂, O₃, N₂O, CO, CH₄, NO and NO₂ (both diurnally and not diurnally corrected), HNO₃, HF, HCl, OCS, H₂CO, HOCl, H₂O₂, HO₂NO₂, N₂O₅, ClONO₂, HCN, CH₃F, CH₃Cl, CF₄, CCl₂F₂, CCl₃F, CCl₄, COF₂, C₂H₆, C₂H₂, N₂, CHF₂Cl, HCOOH, HDO, SF₆ and CH₃D reported at 85 levels from about 5 to 85 km.

CONCLUSIONS AND VALIDATION/

FILTERING

All VMRs profiles are reported in columns, together with corresponding altitude, pressure, temperature. For each altitude IS_DATA filed is provided.

Select only grid point with IS_DATA = T.

DATA AVAILABILITY

V3 of ATMOS data have 6 different file types of data, one for each of three griddings: altitude, pressure, and potential temperature. In addition, each of these gridding formats are available in either a fixed field format (useful for Fortran programs) or tab-delimited (useful for spreadsheets).

ATMOSL2AF : altitude grid, fixed field format:

https://disc.gsfc.nasa.gov/datasets/ATMOSL2AF_3/summary?keywords=ATMOS%20N2O.

ATMOSL2AT: altitude grid, tab-delimited format:

https://disc.gsfc.nasa.gov/datasets/ATMOSL2AT_3/summary?keywords=ATMOS%20N2O.

ATMOSL2PF: pressure grid, fixed field format:

https://disc.gsfc.nasa.gov/datasets/ATMOSL2PF_3/summary?keywords=ATMOS%20N2O.

ATMOSL2AT: pressure grid, tab-delimited format,:

https://disc.gsfc.nasa.gov/datasets/ATMOSL2PT_3/summary?keywords=ATMOS%20N2O.

ATMOSL2PF: potential temperature grid, fixed field format:

https://disc.gsfc.nasa.gov/datasets/ATMOSL2TF_3/summary?keywords=ATMOSL2TF_3.

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 28 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCl4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

ATMOSL2PT: potential temperature grid, tab-delimited format:

https://disc.gsfc.nasa.gov/datasets/ATMOSL2TF_3/summary?keywords=ATMOSL2TT_3

File naming convention is occultation.filter.product.suffix, where

- occultation = mission (sl3 = Spacelab-3, at1 = ATLAS-1, at2 = ATLAS-2 or at3 = ATLAS-3) + type (sr = sunrise or ss = sunset) + number (01-105),
- filter_number = F1-F12 (according to the used spectral range),
- product = oca (altitude gridded), ocp (pressure gridded) or ocpt (potential temperature gridded) for tab-delimited files. Fixed field files have an 'f' appended, i.e. ocaf, ocpf, ocptf.
- suffix = externally compressed using gzip (.gz)

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|--------------------|-------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 29 | | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | | |
| | | | | | | | Version 1.0 | | | |
| | | | 15/03/2024 | | | | | | | |
| N2O | CFC | | | | HCFC | | HFC | | CCI4 | SF6 |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

2.10 CLAES/UARS

| CLAES/UARS N2O products | |
|---------------------------------|---|
| <i>Product type</i> | Daily average of VMR profiles: Level 3 AT and Level 3 AL |
| <i>Level 2 processor</i> | |
| <i>Data version</i> | V 9 |
| <i>Reference</i> | https://acdisc.gesdisc.eosdis.nasa.gov/data/UARS_CLAES_Level3/UARCL3AL/doc/ |
| <i>Geometry</i> | Limb |
| <i>Temporal coverage</i> | 01 October 1991 to 05 May 1993. |
| <i>Spatial coverage</i> | 80S-80N Spatial coverage alternates each UARS yaw cycle. This means that CLAES alternately views from 34N to 80S or 34S to 80N in 36 day periods. |
| <i>Spatial resolution</i> | 4 ° (300 km) x 8.4 km |
| <i>Vertical resolution</i> | Vertical: 2.5 km |
| <i>Useful vertical range</i> | 10 - 60 km. |
| <i>Spectral range</i> | nine filters centered at 2843, 1897, 1605, 1257, 925, 879, 843, 792 and 780 cm ⁻¹ |
| <i>Product characterization</i> | Error |
| <i>Data Format</i> | The CLAES Level 3AT and 3AL data files are written in the Standard Data Format Units (SFDU) format. Each file consists of three records called SFDU, LABEL, and DATA. SFDU and LABEL records contain descriptive information about the instrument and the data, such as start/stop time of the data, number of records in the file, etc. The DATA record contains the profile data and their standard deviations. Time, latitude longitude, local solar time, and solar zenith angles are provided with each DATA record. Each data file is accompanied by a short ASCII metadata file, which provides descriptive information such as the start and stop time of the data, file record lengths, and the UARS quality flag. |
| <i>Contact</i> | kumer@claes.space.lockheed.com |
| <i>Data download</i> | https://disc.gsfc.nasa.gov/datasets/UARCL3AL_009/summary?keywords=CLAES https://disc.gsfc.nasa.gov/datasets/UARCL3AT_009/summary?keywords=CLAES |
| <i>Spectroscopic database</i> | |
| <i>Known problems</i> | N2O: Local maxima in the tropics, 40-20 mb, prior to September 1992. CFC13 : Likely significant interference from Pinatubo aerosol and polar winter PSCs. Most qualitatively-useful data for summer-fall northern hemisphere-looking periods between July 17 and October 26, 1992, and summer-fall southern hemisphere-looking periods between November 2, 1992 and April 15, 1993 |

THE INSTRUMENT

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 30 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

Short description in section [INSTRUMENTS → CLAES short description](#)

DATA OVERVIEW

There are two CLAES level 3A data products archived at the GES DISC:

Level 3AT

CLAES level 3AT data are daily time-ordered data, arranged at time intervals of 65.536 seconds, or about 495 km intervals along the LOS tangent track. The reference time at which level 3AT data are arranged is common across all UARS level 3AT files. Each data record contains time, latitude, longitude, solar zenith angle, local time, and an array of data, as well as an array of quality (standard deviation) values. Data file structures for these file types are found in the Standard Formatted Data Units (SFDU) documents listed in the References section below.

Level 3AL

CLAES level 3AL data are daily latitude- and time-ordered data interpolated from the level 3AT data to intervals of 4 degrees latitude at the intersection of the tangent track of the instruments line of sight (LOS). Each record consists of a single array of data of one parameter for a specific time. Level 3AL data records are written to UARS defined standard latitudes, which range from -88 to +88 degrees in 4 degree intervals.

CONCLUSIONS AND VALIDATION/

FILTERING

Not Applicable

DATA AVAILABILITY

| | | | | | | | | | |
|---|---|-----------|------------|-------------|-----------|-------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 31 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N2O | CFC | | | HCFC | | HFC | | CCI4 | SF6 |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

2.11 ISAMS/UARS

| ISAMS N2O products | |
|---------------------------------|---|
| <i>Product type</i> | L3 data: Daily average of VMR profiles |
| <i>Level 2 processor</i> | |
| <i>Data version</i> | V10 |
| <i>Reference</i> | https://acdisc.gesdisc.eosdis.nasa.gov/data/UARS_ISAMS_Level3/UARIS3AL/doc/ |
| <i>Geometry</i> | limb |
| <i>Temporal coverage</i> | 26 September 1991-29 July 1992 : daily averages |
| <i>Spatial coverage</i> | 80S-80N |
| <i>Spatial resolution</i> | 495 km along track for 3AT 4° along track for 3AL |
| <i>Vertical resolution</i> | 2.5 km |
| <i>Useful vertical range</i> | 15-80 km |
| <i>Spectral range</i> | 4.6 -16.3 micron |
| <i>Product characterization</i> | |
| <i>Data Format</i> | The ISAMS Level 3AT and 3AL data files are written in the Standard Data Format Units (SFDU) format. Each file consists of three records called SFDU, LABEL, and DATA. SFDU and LABEL records contain descriptive information about the instrument and the data, such as start/stop time of the data, number of records in the file, etc. The DATA record contains the profile data and their standard deviations. Time, latitude longitude, local solar time, and solar zenith angles are provided with each DATA record. Each data file is accompanied by a short ASCII metadata file, which provides descriptive information such as the start and stop time of the data, file record lengths, and the UARS quality flag. |
| <i>Contact</i> | taylor@isams.atm.ox.ac.uk |
| <i>Data download</i> | https://disc.gsfc.nasa.gov/datasets/UARIS3AT_010/summary?keywords=UARIS3AT https://disc.gsfc.nasa.gov/datasets/UARIS3AT_010/summary?keywords=UARIS3AT |
| <i>Spectroscopic database</i> | |

THE INSTRUMENT

Short description in [INSTRUMENTS → ISAMS short description](#)

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|--------------------|-------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 32 | | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | | |
| | | | | | | | Version 1.0 | | | |
| | | | | | | | 15/03/2024 | | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

DATA OVERVIEW

There are two ISAMS level 3A data products archived at the GES DISC:

Level 3AT

ISAMS level 3AT data are daily time-ordered data, arranged at time intervals of 65.536 seconds, or about 495 km intervals along the LOS tangent track. The reference time at which level 3AT data are arranged is common across all UARS level 3AT files. Each data record contains time, latitude, longitude, solar zenith angle, local time, and an array of data, as well as an array of quality (standard deviation) values. Data file structures for these file types are found in the Standard Formatted Data Units (SFDU) documents listed in the References section below.

Level 3AL

ISAMS level 3AL data are daily latitude- and time-ordered data interpolated from the level 3AT data to intervals of 4 degrees latitude at the intersection of the tangent track of the instruments line of sight (LOS). Each record consists of a single array of data of one parameter for a specific time. Level 3AL data records are written to UARS defined standard latitudes, which range from -88 to +88 degrees in 4 degree intervals.

ISAMS Level 3A data are generated by interpolating the ISAMS Level 2 profiles to standard UARS surfaces (using the Level 2 pressure files) then interpolating along the tangent track to standard output times (3AT files) or latitude crossings (3AL files). Associated with each 3A data file is a parameter file (3TP with 3AT, 3LP with 3AL), containing additional information on ISAMS operation conditions for each data profile, parameters which are not accommodated in the standard UARS 3A data format.

Level 3ALP data are generated from ISAMS Level 2 Data files at the same time as Level 3AL data files. Where appropriate, the values contained in Level 3ALP (and also 3AL) are derived from the level 2 profiles by linear interpolation in observation time between adjacent profiles. This is necessary because the Level 2 profiles are provided at fixed times where the Level 3AL products are required at fixed latitudes. No attempt is made to interpolate between successive profiles that are in different 'modes'.

CONCLUSIONS AND VALIDATION/

FILTERING

All data are checked by the ISAMS science team and assigned quality values. These values appear as the DATA_QUALITY_UARS fields in the ASCII metadata files. The format for DATA_QUALITY_UARS is a 3 character field of the form "p.q" where:

| | VALUE | MEANING |
|-------|-------|---------------------------|
| for p | 0 | Machine inspected |
| | 1 | Qualitative evaluation |
| | 2 | Intensive analysis |
| for q | 1 | less than 50% good data |
| | 2 | 50% - 75% good data |
| | 3 | 76% - 98% good data |
| | 4 | better than 98% good data |

ISAMS uses the DATA_QUALITY_PI field to indicate data coverage on an orbital basis. All parameter/subtypes will have the same value most days. The format for DATA_QUALITY_PI is a 3 character field of the form "abc" where:

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 33 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

a = N +Y side of UARS pointing north all day
a = S +Y side of UARS pointing south all day
(the +Y, or cold side of UARS, is the dominant view for ISAMS)

b = 0,1,...F (hex) Number of +Y tangent tracks [0-15]

c = 0,1,...F (hex) Number of -Y tangent tracks [0-15]
c = X No -Y views attempted

Example:
"NAX" Cold side (+Y) pointing north, 10 +Y orbit tracks,
no -Y views attempted

| | | | | | | | | | |
|---|---|-----------|------------|-------------|-----------|-------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 34 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N2O | CFC | | | HCFC | | HFC | | CCI4 | SF6 |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

2.12 CRISTA

The CRISTA instrument has flown twice on the Space Shuttle from 1994 to 1997 (see Temporal coverage in the Table below).

5 of the trace species retrieved from CRISTA measurements are of interest for LOLIPOP, namely N2O, CF4, CCI4, CCI3F (CFC-11) and CCI2F2 (CFC-12).

| CRISTA products | |
|---------------------------------|---|
| <i>Product type</i> | Profiles |
| <i>Level 2 processor</i> | |
| <i>Data version</i> | |
| <i>Reference</i> | Riese, M., R. Spang, P. Preusse, M. Ern, M. Jarisch, D. Offermann and K.U. Grossmann, "Cryogenic Infrared Spectrometers and Telescopes for the Atmosphere (CRISTA) data processing and atmospheric temperature and trace gas retrieval", J. Geophys. Res., 104, 16349-16367, 1999. Grossmann, K.U., D. Offermann, O. Gusev, J. Oberheide, M. Riese, and R. Spang, "The CRISTA-2 mission", J. Geophys. Res., 107 (D23), 8173, doi:10.1029/2001JD000667, 2002. |
| <i>Geometry</i> | limb |
| <i>Temporal coverage</i> | STS-66/ATLAS-3 (November 3 to 12, 1994). ASTRO-SPAS (August 8 to 16, 1997) |
| <i>Spatial coverage</i> | |
| <i>Spatial resolution</i> | horizontal (ca. 500 km x 650 km) |
| <i>Vertical resolution</i> | ca. 2-3 km |
| <i>Useful vertical range</i> | Vertical range between 15-150 km , different for different measurement modes |
| <i>Spectral range</i> | 4.18-70 micron |
| <i>Product characterization</i> | |
| <i>Data Format</i> | |
| <i>Contact</i> | Oleg Goussev (DLR-DFD, oleg.goussev@dlr.de) and Reinhold Spang – Julich23 |
| <i>Data download</i> | Data are archived at DFD/DLR (M. Bittner) |
| <i>Spectroscopic database</i> | |

THE INSTRUMENT

Short description in section [INSTRUMENTS](#) → CRISTA short description

DATA OVERVIEW

CONCLUSIONS AND VALIDATION/

FILTERING

DATA AVAILABILITY

| | | | | | | | | | |
|---|---|-----------|------------|-------------|-----------|-------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 35 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| <u>N₂O</u> | <u>CFC</u> | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

2.13 TES

| | |
|------------------------------------|--|
| TES N₂O products | |
| <i>Product type</i> | Both total column density and profile (with AK) |
| <i>Level 2 processor</i> | |
| <i>Data version</i> | V8 |
| <i>Reference</i> | https://asdc.larc.nasa.gov/documents/tes/guide/TESDataUsersGuideV8_0_March_27_2020_FV-8_rh.pdf https://cmr.earthdata.nasa.gov/search/concepts/C1616452212-LARC.html Worden et al, 2012, doi:10.5194/amt-5-397-2012 |
| <i>Geometry</i> | Nadir (mainly) |
| <i>Temporal coverage</i> | 2004-08-22 - 2018-01-22 |
| <i>Spatial coverage</i> | Global |
| <i>Spatial resolution</i> | |
| <i>Vertical resolution</i> | |
| <i>Useful vertical range</i> | |
| <i>Spectroscopic database</i> | |
| <i>Spectral range</i> | 1100-1330 cm ⁻¹ |
| <i>Product characterization</i> | Precision and total error CM, AK, total column density error The total error is the sum of the smoothing, observation, and temperature error (from https://amt.copernicus.org/articles/5/397/2012/amt-5-397-2012.pdf) |
| <i>Data Format</i> | HDF-EOS5 |
| <i>Contact</i> | scott.gluck@jpl.nasa.gov |
| <i>Data download</i> | https://asdc.larc.nasa.gov/project/TES/TL2N2ON_8 Registration to EARTHDATA is needed |
| <i>Recommendation</i> | – |

THE INSTRUMENT

Short description in section [INSTRUMENTS → TES short description](#)

DATA OVERVIEW

TL2N2ON_8 is the Tropospheric Emission Spectrometer (TES)/Aura Level 2 Nitrous Oxide Nadir Version 8 data product. It consists of information for one molecular species, Nitrous Oxide, for an entire Global Survey or Special Observation. TES Level 2 data contain retrieved species (or temperature) profiles at the observation targets and the estimated errors. The geolocation, quality, and other data (e.g., surface characteristics for nadir observations) were also provided. L2 modeled spectra were evaluated using radiative transfer modeling algorithms. The process, referred to as retrieval, compared observed spectra to the modeled

| | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 36 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N2O | CFC | | | | HCFC | | HFC | CCl4 | SF6 |
| | 11 | 12 | 113 | CF4 | 22 | 142b | 23 | 134a | |

spectra and iteratively updated the atmospheric parameters. L2 standard product files included information for one molecular species (or temperature) for an entire global survey or special observation run. A global survey consisted of a maximum of 16 consecutive orbits

NASA/LARC/SD/ASDC. (n.d.). TES/Aura L2 Nitrous Oxide Nadir V008 [Data set]. NASA Langley Atmospheric Science Data Center DAAC. Retrieved from <https://doi.org/10.5067/AURA/TES/TL2N2ON.008>

<https://cmr.earthdata.nasa.gov/search/concepts/C1616452212-LARC.html>

CONCLUSIONS AND VALIDATION/

FILTERING AND DATA QUALITY

Information taken from User Guide:

https://asdc.larc.nasa.gov/documents/tes/guide/TESDataUsersGuideV8_0_March_27_2020_FV-8_rh.pdf (Sect.6.1 and Sect. 6.3)

A set of quality sub-flags is provided in the files, as listed in the table below, the product is good if all the 10 variables are within the ranges reported in the table. There is also a "master" quality flag (SpeciesRetrievalQuality) but it is recommend not to use for N2O.

Table 6-8 Recommended Ranges for TES L2 Quality Flags for Water Vapor, HDO, Nitrous Oxide and Methane

Table 6-8 Recommended Ranges for TES L2 Quality Flags for Water Vapor, HDO, Nitrous Oxide and Methane

| Flag | Minimum Value | Maximum Value |
|-----------------------------|---------------|---------------|
| AverageCloudEffOpticalDepth | 0 | 50 |
| CloudVariability_QA | 0 | 2 |
| SurfaceEmissMean_QA | -0.06 | 0.06 |
| KDotDL_QA | -0.2 | 0.2 |
| LDotDL_QA | -0.1 | 0.1 |
| CloudTopPressure | 90 | 1300 |
| SurfaceTempvsApriori_QA | -4 | 4 |
| SurfaceTempvsAtmTemp_QA | -30 | 30 |
| RadianceResidualMean | -0.05 | 0.05 |
| RadianceResidualRMS | 0.5 | 1.75 |

DATA AVAILABILITY

Available online after EARTHDATA registration at:

https://asdc.larc.nasa.gov/project/TES/TL2N2ON_8

| | | | | | | | | | |
|---|---|-----------|------------|-------------|-----------|-------------|--------------------|-------------|-----------------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 37 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N₂O | CFC | | | HCFC | | HFC | | CCI4 | SF₆ |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

2.14 AIRS-CLIMCAPS

| AIRS (N ₂ O) CLIMCAPS products | |
|---|---|
| <i>Product type</i> | Partial column at 100 layers between 100 and 1000 hPa (n2o_mol_lay) obtained from the combination of AIRS and AMSU |
| <i>Level 2 processor</i> | CLIMCAPS |
| <i>Data version</i> | V2 |
| <i>Reference</i> | Nadia Smith, Rebekah Esmaili, Chris D. Barnet, Community Long-term Infrared Microwave Combined Atmospheric Product System (CLIMCAPS) Science Application Guides. (Available in the Documentation on the website for data download) Smith, N. and Barnet, C. D https://doi.org/10.5194/amt-13-4437-2020 |
| <i>Geometry</i> | nadir |
| <i>Temporal coverage</i> | 2002-08-31 to 2016-09-26 |
| <i>Spatial coverage</i> | global |
| <i>Spatial resolution</i> | 13.5 km |
| <i>Vertical grid</i> | 100 pressure layers |
| <i>Useful vertical range</i> | 1000-100 hPa |
| <i>Spectroscopic database</i> | |
| <i>Spectral range</i> | 2150-2250 cm ⁻¹ + Microwave |
| <i>Product characterization</i> | Error of the partial column (n2o_mol_lay_err), see https://www.mdpi.com/2072-4292/11/10/1227 |
| <i>Data Format</i> | NetCDF |
| <i>Contact</i> | Nadia Smith: nadiaz@stcnet.com |
| <i>Data download</i> | GES DISC Data Release:Data Release for CLIMCAPS Level 2 Aqua AIRS/AMSU instruments DOI: 10.5067/JZMYK5SMYM86 |
| <i>Recommendation</i> | – |

THE INSTRUMENT

Short description in section [INSTRUMENTS → AIRS \(CLIMCAPS observing system\)](#) short description

DATA OVERVIEW

It combines AIRS (IR) and AMSU (MW) measurements

The Level-2 products are divided into a series of 6-minute segments with one segment per file. Each file contains all observations of a given type made during a period of exactly 6

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 38 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| N2O | CFC | | | | HCFC | | HFC | | CCI4 | SF6 |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

minutes. For each day there are 240 files (also known as granules), identified by granule number in the filename: g021 is granule 21 out of 240. For granule start time details, refer to section 2.1.

CONCLUSIONS AND VALIDATION

Validation using the aircraft measurement profiles by HIPPO (see references)

FILTERING AND QUALITY FLAGGING

For most retrieved geophysical variables, a numerical error estimate in the same physical units is provided in a corresponding ancillary_variable with a name ending in "_err". There are also Quality Control (QC) scores of {0, 1, 2} in corresponding ancillary_variables with a name ending in "_qc".

Value Meaning

- 0 Highest quality – use without reservation
- 1 Good quality – suitable for most purposes
- 2 Do not use. In some cases a physical value is present but is not considered reliable. In other cases only fill values are present

N2o_mol_lay_qc (0,1,2). flag_meanings = "Best Good Do_Not_Use"

DATA AVAILABILITY

Available online DOI: 10.5067/JZMYK5SMYM86

| | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 39 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N2O | CFC | | | | HCFC | | HFC | CCI4 | SF6 |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

2.15 CrIS-CLIMCAPS /SUOMI NPP

| | |
|---------------------------------|---|
| CrIS-CLIMCAPS products | |
| <i>Product type</i> | Partial column at 100 layers between 0.3 and 1085 hPa (n2o_mol_layer (atoms/m2)) obtained from the combination of CrIS and ATMS measurements |
| <i>Level 2 processor</i> | CLIMCAPS |
| <i>Data version</i> | V2 |
| <i>Reference</i> | Nadia Smith, Rebekah Esmaili, Chris D. Barnet, Community Long-term Infrared Microwave Combined Atmospheric Product System (CLIMCAPS) Science Application Guides (available in the Documentation on the website for data download) Smith, N. and Barnet, C. D.: CLIMCAPS observing capability for temperature, moisture, and trace gases from AIRS/AMSU and CrIS/ATMS, Atmos. Meas. Tech., 13, 4437–4459, https://doi.org/10.5194/amt-13-4437-2020 , 2020. |
| <i>Geometry</i> | nadir |
| <i>Temporal coverage</i> | 2015-2021 |
| <i>Spatial coverage</i> | 50x 50 km |
| <i>Spatial resolution</i> | |
| <i>Vertical resolution</i> | |
| <i>Useful vertical range</i> | |
| <i>Spectral range</i> | 1270-1300 cm ⁻¹ + Microwave |
| <i>Product characterization</i> | Error (n2o_mol_layer_err), see https://www.mdpi.com/2072-4292/11/10/1227 |
| <i>Data Forma</i> | NetCDF |
| <i>Contact</i> | sounder.sips@jpl.nasa.gov |
| <i>Data download</i> | https://disc.gsfc.nasa.gov/datasets/SNDRSNIML2CCPRET_2/summary/ |
| <i>Recommendation</i> | - |

THE INSTRUMENT

Short description in section

[INSTRUMENTS → AIRS \(CLIMCAPS observing system\) short description](#)

DATA OVERVIEW

In 2017, the Community Long-term Infrared Microwave Combined Atmospheric Product System (CLIMCAPS) was funded to be the National Aeronautics and Space Administration (NASA) continuity algorithm for satellite-sounding observations from Atmospheric Infrared Sounder (AIRS) Atmospheric Microwave Sounding Unit (AMSU) (on Aqua since 2002) and

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|--------------------|-------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 40 | | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | | |
| | | | | | | | Version 1.0 | | | |
| | | | | | | | 15/03/2024 | | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

Cross-track Infrared Sounder (CrIS) Advanced Technology Microwave Sounder (ATMS) (on Suomi-NPP since 2011 and NOAA-20 since 2017). Three years later, the full CLIMCAPS record spanning two decades was publicly released (see Open Research section for details about the existing Version 2 record). This was the first time the research and operational communities had access to a consistent record of satellite soundings from multiple instruments and platforms to evaluate large-scale, long-term processes.

CONCLUSIONS AND VALIDATION/

FILTERING

n2o_mol_lay_qc (0, 1, 2)

flag_meanings = "Best Good Do_Not_Use"

DATA AVAILABILITY

| | | | | | | | | | | |
|---|---|-----------|------------|-----------------------|-------------|-------------|--------------------|-------------|------------------------|-----------------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 41 | | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | | |
| | | | | | | | Version 1.0 | | | |
| | | | | | | | 15/03/2024 | | | |
| <u>N₂O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCl₄</u> | <u>SF₆</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF₄</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

2.16 TANSO-FTS

| TANSO-FTS N ₂ O products | |
|-------------------------------------|--|
| <i>Product type</i> | Total Column |
| <i>Level 2 processor</i> | FOCAL |
| <i>Data version</i> | 3.01 |
| <i>Reference</i> | https://doi.org/10.5194/amt-15-3401-2022 |
| <i>Geometry</i> | Nadir |
| <i>Temporal coverage</i> | 2019-2021 |
| <i>Spatial coverage</i> | Global |
| <i>Spatial resolution</i> | IFOV= 9.7 Km |
| <i>Vertical resolution</i> | Total column |
| <i>Useful vertical range</i> | Total column |
| <i>Spectroscopic database</i> | |
| <i>Spectral range</i> | 4364-4449 cm ⁻¹ |
| <i>Product characterization</i> | Random Error, AK |
| <i>Data Format</i> | NetCDF |
| <i>Contact</i> | Stefan Noel (stefan.noel@iup.physik.uni-bremen.de) |
| <i>Data download</i> | LOLIPOP internal repository |
| <i>Recommendation</i> | <p>Please note our usual conditions of use: When using FOCAL data, you agree ...</p> <ul style="list-style-type: none"> - to inform us prior to any publication where FOCAL data products are planned to be used, - to offer us co-authorship for any planned peer-reviewed publication based on FOCAL data products (for non peer-reviewed publications it is sufficient if you add an appropriate acknowledgement), - not to distribute the FOCAL data products to any third party (the only exception being colleagues working in your institute, in this case you agree to inform them about the conditions listed here and that they also have to accept these conditions) |

THE INSTRUMENT

Short description in section [INSTRUMENTS → TANSO-FTS short description](#)

DATA OVERVIEW

There is no N₂O product available for GOSAT-2 in the official repository (NIES GOSAT Data Archive Service - GDAS).

| | | | | | | | | | |
|---|---|-----------|------------|-----------------------|-----------|-------------|--------------------|------------------------|-----------------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 42 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N₂O | CFC | | | HCFC | | HFC | | CCl₄ | SF₆ |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF₄</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

The N₂O data selected have been retrieved by S. Noel et al for scientific purposes (see the paper reported in reference) by using the Fast atmOspheric traCe gAs retrieval (FOCAL) retrieval method applied GOSAT-2 measurements.

CONCLUSIONS AND VALIDATION

Conclusions from the paper Noel et al. (Retrieval of greenhouse gases from GOSAT and GOSAT-2 using the FOCAL algorithm):

...

The spatial distribution of all gases and their temporal variation look reasonable. We have presented the first results for a GOSAT-2 XN₂O product. We observe an XN₂O gradient between the tropics and higher latitudes of about 15 ppb which can be explained by variations in the tropopause height. A similar gradient has been seen in IASI data.

...

The accuracy of the GOSAT-2 FOCAL XN₂O is in the order of a few parts per billion (ppb) for a single sounding. We expect this to be improved by averaging of data such that, for example, monthly or annually gridded products can provide interesting information about XN₂O, especially since there are not many global satellite measurements available for this species.

For XN₂O, we get from the TCCON comparison a station-to-station bias of 1.6 ppb and a mean scatter of 4.0 ppb. The seasonal bias is 1.6 ppb. Since the corresponding 1σ FOCAL uncertainty from Wunch et al. (2010) is 1.5 ppb, we consider this to be reasonable agreement. ... Both TCCON and GOSAT-2 observe total column seasonal variations with peak-to-peak differences of about 8 ppb, which is in line with the time series results. There is no visible bias between TCCON and GOSAT-2, but the scatter of the GOSAT-2 data is larger.

FILTERING AND DATA QUALITY

Cloud filtering is applied in the preprocessor; convergence filtering and data quality filtering are performed in post-processing.

The final data product contains only the filtered data.

DATA AVAILABILITY

Stephan Noel, author of the paper, has been contacted; he provided a link for downloading FOCAL data as yearly gzipped tar archives (2019-021) from:
http://www.iup.uni-bremen.de/~noel/Data/FOCAL/GOSAT-2/v3.0.1_yearly/N2O/.

Data have been already downloaded and now they are available on the LOLIPOP repository at CNR-IFAC premises

| | | | | | | | | | |
|---|---|-----------|------------|-----------------------|-----------|-------------|--------------------|-------------|-----------------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 43 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N₂O | CFC | | | HCFC | | HFC | | CCI4 | SF₆ |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF₄</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

2.17 IASI (EUMETSAT)

| IASI (EUMETSAT) N ₂ O product | |
|--|---|
| <i>Product type</i> | Total column |
| <i>Level 2 processor</i> | Artificial neural networks (ANN) |
| <i>Data version</i> | Demonstrational |
| <i>Reference</i> | IASI Level 2 Product Guide (https://user.eumetsat.int/s3/eup-strap-media/IASI_Level_2_Product_Guide_8f61a2369f.pdf) |
| <i>Geometry</i> | nadir |
| <i>Temporal coverage</i> | 2009-now |
| <i>Spatial coverage</i> | global |
| <i>Spatial resolution</i> | IASI IFOV |
| <i>Vertical resolution</i> | Total column |
| <i>Useful vertical range</i> | Total column |
| <i>Spectroscopic database</i> | |
| <i>Spectral range</i> | |
| <i>Product characterization</i> | Accuracy less than 20% |
| <i>Data Format</i> | EPS native format or netCDF |
| <i>Contact</i> | EUMETSAT Data Service |
| <i>Data download</i> | EUMETSAT Data Service |
| <i>Recommendation</i> | Product not validated, not of high quality |

THE INSTRUMENT

Short description in section [INSTRUMENTS → IASI short description](#)

DATA OVERVIEW

The total columns of N₂O are retrieved with artificial neural networks trained with synthetic radiances (using RTTOV) and a collection of trace gas profiles from the MOZART model. They are generated in a Demonstrational mode and have not been validated. Work is on-going to upgrade the retrieval algorithm.

CONCLUSIONS AND VALIDATION

They are generated in a Demonstrational mode and have not been validate

FILTERING AND DATA QUALITY

Validity check of the final geophysical retrieved parameters is reported in the Level2 data file.

DATA AVAILABILITY

Data available at EUMETSAT Data Service.

| | | | | | | | | | |
|---|---|-----------|------------|-------------|-----------|-------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 44 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCl4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

2.18 IASI (NOPIR)

| IASI (NOPIR) N ₂ O products | |
|--|---|
| <i>Product type</i> | Profile |
| <i>Level 2 processor</i> | NOPIR |
| <i>Data version</i> | 1 |
| <i>Reference</i> | https://doi.org/10.3390/rs14081810 |
| <i>Geometry</i> | nadir |
| <i>Temporal coverage</i> | 2011.02-2020 |
| <i>Spatial coverage</i> | global |
| <i>Spatial resolution</i> | I FOV 12km at nadir |
| <i>Vertical resolution</i> | variable, max 2 DOF |
| <i>Useful vertical range</i> | 800-80 hPa |
| <i>Spectroscopic database</i> | |
| <i>Spectral range</i> | 2170-2215cm ⁻¹ (nu3 band) |
| <i>Product characterization</i> | Random and systematic error, AK, DOFs |
| <i>Data Format</i> | hdf5 |
| <i>Contact</i> | Sophie Vandebussche (BIRA-IASB) |
| <i>Data download</i> | BIRA-IASB inhouse |
| <i>Recommendation</i> | – |

THE INSTRUMENT

Short description in section [INSTRUMENTS → IASI short description](#)

DATA OVERVIEW

xxxx.

CONCLUSIONS AND VALIDATION

Validation against NDACC and TCCON, at the pixel level, of integrated column: 1.8 to 4% positive bias (with 1.5 to 3% standard deviation), except at high North latitude TCCON stations (where another analysis has shown that TCCON data can be biased), and in Antarctica (yet unexplained, but there is only one NDACC station available and its data is reported with a relatively high mean systematic bias of 3.5%). Estimated uncertainties on the NOPIR columns are usually of 1 to 3% (mostly random). See more in the reference paper

FILTERING AND DATA QUALITY

see section 4.1 in the paper (no quality flag saved in the data)

DATA AVAILABILITY

Available at BIRA

| | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 45 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N2O | CFC | | | | HCFC | | HFC | CCI4 | SF6 |
| | 11 | 12 | 113 | CF4 | 22 | 142b | 23 | 134a | |

2.19 IASI (SOFRID)

| IASI (SOFRID) N2O product | |
|---------------------------------|---|
| <i>Product type</i> | Monthly (daily) mean of : Total column, VMR, mean VMR in 700-350 hPa |
| <i>Level 2 processor</i> | SOFRID |
| <i>Data version</i> | v2.3 |
| <i>Reference</i> | https://doi.org/10.3390/atmos12020219 |
| <i>Geometry</i> | nadir |
| <i>Temporal coverage</i> | 2014 and the whole timeseries at the FTIR-NDACC stations that were used for validation |
| <i>Spatial coverage</i> | global nighttime and daytime |
| <i>Spatial resolution</i> | |
| <i>Vertical resolution</i> | |
| <i>Useful vertical range</i> | |
| <i>Spectroscopic database</i> | |
| <i>Spectral range</i> | |
| <i>Product characterization</i> | |
| <i>Data Format</i> | |
| <i>Contact</i> | Brice Barret |
| <i>Data download</i> | On request to Brice Barret |
| <i>Recommendation</i> | – |

THE INSTRUMENT

Short description in section [INSTRUMENTS → IASI short description](#)

DATA OVERVIEW

The SOFRID has been developed for near-real time retrieval of global O3 and CO profiles from IASI radiances. SOFRID is based on the RTTOV radiative transfer model coupled to the 1D-Var algorithm developed at UK Met Office (UKMO)

CONCLUSIONS AND VALIDATION

The agreement is better for tropical and SH stations ($0.68 < R < 0.83$) than for NH stations.

SOFRID retrievals display significant negative biases (–17 to –4 ppbv) at NH continental stations. At tropical and SH mid-latitude stations, the biases are lower (–7.6 to 1.3 ppbv) and mostly not significant. The better agreement found at tropical and SH stations is due to their oceanic or coastal locations highlighting better SOFRID retrievals for sea pixels.

<https://doi.org/10.3390/atmos12020219>

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 46 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCl4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

FILTERING AND DATA QUALITY

Retrievals are performed for cloud-clear scenes only (cloud fraction derived from AVHRR below 15%). In addition, for missing AVHRR cloud data, a cloud filtering based on IASI brightness temperatures at 11 and 12 m is applied.

DATA AVAILABILITY

The SOFRID-N2O data are currently available upon request to Brice Barret.

Available monthly (and daily) means

| | | | | | | | | | |
|---|---|-----------|------------|-----------------------|-------------|-------------|--------------------|------------------------|-----------------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 47 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N₂O | CFC | | | | HCFC | | HFC | CCl₄ | SF₆ |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF₄</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

2.20 IASI (TN2OR)

| IASI (TN2OR) N ₂ O product | |
|---------------------------------------|---|
| <i>Product type</i> | Partial columns |
| <i>Level 2 processor</i> | TN2OR |
| <i>Data version</i> | V 2.0 |
| <i>Reference</i> | https://doi.org/10.3390/rs14061403 |
| <i>Geometry</i> | nadir |
| <i>Temporal coverage</i> | Year 2011 (from 01/2011 to 12/2011) |
| <i>Spatial coverage</i> | |
| <i>Spatial resolution</i> | |
| <i>Vertical resolution</i> | 14 pressure levels |
| <i>Useful vertical range</i> | |
| <i>Spectroscopic database</i> | |
| <i>Spectral range</i> | 1240–1350 cm ⁻¹ |
| <i>Product characterization</i> | VCM, Averaging Kernel Matrix |
| <i>Data Format</i> | netCDF |
| <i>Contact</i> | Jean-Luc Attié, Uni-Toulouse (jean-luc.attie@aero.obs-mip.fr) |
| <i>Data download</i> | Data available at IFAC repository |
| <i>Recommendation</i> | – |

THE INSTRUMENT

Short description in section [INSTRUMENTS → IASI short description](#)

DATA OVERVIEW

The N₂O data selected have been retrieved by the TN2OR version 2.0; this tool estimates the vertical profiles of N₂O from clear-sky IASI observations. TN2OR uses RTTOV v12.3 radiative transfer model and the Levenberg-Marquardt optimal estimation.

The a-priori profile is an average of several HIPPO profiles extrapolated by using LMDz-INCA model output.

CONCLUSIONS AND VALIDATION

Conclusions from the paper R. Chalinel et al. (Evaluation and Global-Scale Observation of Nitrous Oxide from IASI on Metop-A):

...

For one single retrieval, the total random error of IASI N₂O at 300 hPa has been found around 0.60% and also for 300–500 hPa in favorable conditions..

| | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 48 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N2O | CFC | | | | HCFC | | HFC | CCI4 | SF6 |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

...

The IASI N₂O data set has been evaluated against the aircraft N₂O observations from the HIPPO campaigns in 2009, 2010 and 2011 and the NOAA aircraft campaigns held in 2011, and also against the ground-based N₂O measurements from nine stations belonging to the NDACC network. We found values of global correlation coefficients of ~0.77 between IASI and aircraft data. The bias between IASI and aircraft N₂O data is relatively small with ~1.0 ppbv..

In the same way, the correlation between IASI and Northern Hemisphere NDACC stations (Kiruna, St Petersburg, Zugspitze, Jungfraujoch and Tenerife) is greater than 0.56 and could reach 0.85. The bias between IASI and NDACC data depends on the month but is generally small during summer for the northern hemisphere stations and quite constant over the year for the southern hemisphere stations (~5 ppbv) except for Reunion island (~7 ppbv). Moreover, the IASI variability is quite similar for Zugspitze and Jungfraujoch but usually twice less than the NDACC variability...

FILTERING AND DATA QUALITY

No information about filtering is provided.

DATA AVAILABILITY

Jean-Luc Attié, co-author of the paper, has been contacted; he provided the full N₂O dataset retrieved by TN2OR for the year 2011.

Data have been already downloaded and now they are available on the LOLIPOP repository at CNR-IFAC premises.

N₂O data are provided in a netCDF file for each day of year 2011; files are arranged in 13 directories, one for each month

| | | | | | | | | | |
|---|---|-----------|------------|-----------------------|-------------|-------------|--------------------|------------------------|-----------------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 49 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N₂O | CFC | | | | HCFC | | HFC | CCl₄ | SF₆ |
| | 11 | 12 | 113 | CF₄ | 22 | 142b | 23 | 134a | |

2.21 IASI-MUSICA

| IASI-MUSICA products | |
|---------------------------------|---|
| <i>Product type</i> | VMR vertical profiles (provided in ppmv) |
| <i>Level 2 processor</i> | PROFFIT-nadir (Schneider and Hase, 2011; Wiegeler et al., 2014) |
| <i>Data version</i> | |
| <i>Reference</i> | https://doi.org/10.5194/essd-14-709-2022 |
| <i>Geometry</i> | nadir |
| <i>Temporal coverage</i> | 2014–2019 |
| <i>Spatial coverage</i> | global |
| <i>Spatial resolution</i> | |
| <i>Vertical resolution</i> | |
| <i>Useful vertical range</i> | |
| <i>Spectroscopic database</i> | |
| <i>Spectral range</i> | 1190 and 1400 cm ⁻¹ |
| <i>Product characterization</i> | Variance Covariance Matrix, Averaging Kernel, DoF |
| <i>Data Format</i> | netCDF files compliant with version 1.7 of the CFmetadata convention |
| <i>Contact</i> | |
| <i>Data download</i> | DOI:10.35097/412 |
| <i>Recommendation</i> | Note that all the information reported in this section has been extracted from the paper indicated in the reference (https://doi.org/10.5194/essd-14-709-2022) |

THE INSTRUMENT

Short description in section [INSTRUMENTS → IASI short description](#)

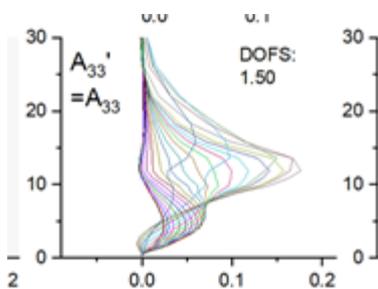
DATA OVERVIEW

The N₂O MUSICA products consists in VMR vertical profiles on 28 altitude levels, with associated detailed information on their sensitivity, vertical representativeness, and errors. For a limited number of retrievals an extended netCDF output file is provided, containing, in addition, the full averaging kernels and a large set of Jacobians and gain matrices.

The processing algorithm consists in a Line-by-line radiative transfer code based on HITRAN2016 molecular spectroscopic database with the MT_CKD v2.5.2 continuum model.

For the N₂O, the DOFS values are clearly larger than 1.0, indicating the capability of the retrieval to provide some information on the trace gases' vertical distribution.

| | | | | | | | | | | |
|---|---|-----------|------------|-----------------------|-------------|-------------|--------------------|-------------|------------------------|-----------------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 50 | | | |
| | OLLGHG_s INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | | |
| | | | | | | | Version 1.0 | | | |
| | | | | | | | 15/03/2024 | | | |
| <u>N₂O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCl₄</u> | <u>SF₆</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF₄</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |



The MUSICA IASI full product data are provided as netCDF files compliant with version 1.7 of the CF (Climate and Forecast) metadata convention (<https://cfconventions.org>). Files are provided in daily .tar files, with all orbits of all IASI instruments archived into a single .tar file.

Because the MUSICA IASI retrieval builds upon the EUMETSAT L2 cloud filter and uses the EUMETSAT L2 atmospheric temperature as the a priori atmospheric temperature, the output files contain some EUMETSAT retrieval data...

CONCLUSIONS AND VALIDATION/

FILTERING AND DATA QUALITY

The MUSICA products are currently restricted to cloud-free scenarios. The selection of cloud-free conditions is made by means of the EUMETSAT L2 PPF cloudiness assessment summary flag variable (flag=1 indicating that IFOV is clear, or flag=2 indicating that small cloud contamination is possible). This requirement for cloud-free scenarios removes more than two-thirds of all available IASI observations.

DATA AVAILABILITY

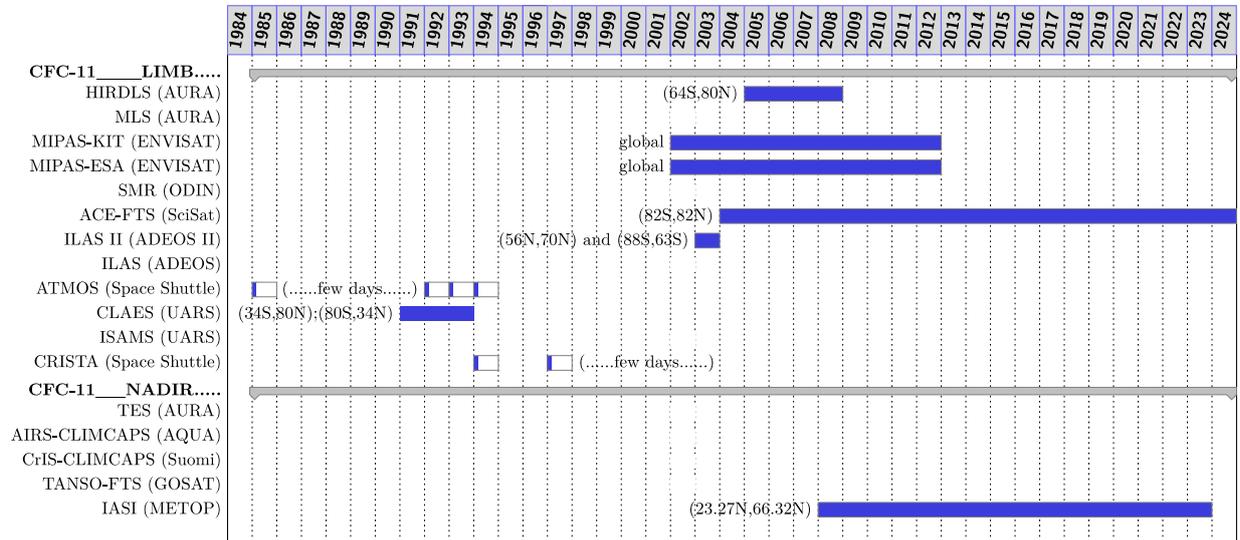
The data are provided with the license: CC BY 4.0 Attribution

The MUSICA IASI data can be freely downloaded at <http://www.imk-asf.kit.edu/english/musica-data.php> (last access: 25 January 2022). We offer two data packages with DOIs. The first data package has a data volume of about 17.5 GB and is linked to via <https://doi.org/10.35097/408> (Schneider et al., 2021b). It contains example standard output data files for all MUSICA IASI retrievals made for a single day (more than 0.6 million) and a description of how to access the total data set (2014–2019, data volume 25 TB) or parts of it

| | | | | | | | | | | |
|---|---|-----------|------------|------------|--------------------|-------------|------------|-------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | Page 51 | | | | | |
| | OLLGHGs INVENTORY (URD) | | | | [D1.1] LOLIPOP_URD | | | | | |
| | | | | | Version 1.0 | | | | | |
| | | | | | 15/03/2024 | | | | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

3 CFC-11

| INSTRUMENT SELECTOR | | | |
|---------------------|------------------|-------------|------------------|
| LIMB | <u>HIRDLS</u> | --- | <u>MIPAS-KIT</u> |
| | <u>MIPAS-ESA</u> | --- | <u>ACE-FTS</u> |
| | <u>ILAS II</u> | --- | <u>ATMOS</u> |
| | <u>CLAES</u> | --- | <u>CRISTA</u> |
| NADIR | --- | --- | --- |
| | --- | <u>IASI</u> | --- |
| | --- | --- | --- |



| | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 52 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N2O | CFC | | | | HCFC | | HFC | CCI4 | SF6 |
| | 11 | 12 | 113 | CF4 | 22 | 142b | 23 | 134a | |

3.1 HIRDLS/AURA

| HIRDLS CFC-11 products | |
|--------------------------|---|
| Product type | VMR profile |
| Level 2 processor | |
| Data version | L2 V7 |
| Reference | https://docserver.gesdisc.eosdis.nasa.gov/repository/Mission/HIRDLS/3.3_Product_Documentation/3.3.5_Product_Quality/HIRDLS-DQD_V7.pdf |
| Geometry | limb |
| Temporal coverage | January 29, 2005 - March 17, 2008. |
| Spatial coverage | +80 to -64 degrees latitude |
| Spatial resolution | horizontal resolution of the observations is approximately 100 km |
| Vertical resolution | 1-1.2 km |
| Useful vertical range | 316 – 17.8 hPa |
| Spectroscopic database | |
| Spectral range | 21 channels ranging from 6.12 to 17.76 microns |
| Product characterization | Estimated precision, AK |
| Data Format | HDF-EOS5 |
| Contact | Bruno Nardi (nardi@ucar.edu); (not contacted) |
| Data download | https://disc.gsfc.nasa.gov/datasets/HIRDLS2_007/summary?keywords=HIRDLS |
| Recommendation | – |

*Information extracted from the README and Data Quality document:
"High Resolution Dynamics Limb Sounder Earth Observing System (EOS) Data Description and Quality Version 7 (V7) (HIRDLS Version 7.00.00) June, 2013*

THE INSTRUMENT

Short description in [INSTRUMENTS](#) → [HIRDLS short description](#)

DATA OVERVIEW

The "HIRDLS/Aura Level 2 Geophysical Parameters" data product (HIRDLS2) contains an entire day's worth of Level-2 vertical profiles of O3, HNO3, H2O, CFC-11, CFC-12, N2O, NO2, N2O5, ClONO2, temperature, geopotential height, and aerosol extinction at 12.1 and 8.3 microns, as well as cloud top pressure.

The precision estimated from the average of 10 sets of 12 sequential profiles in undisturbed regions indicates precisions of 0.005-0.025 ppbv (5%-20%) for CFC11, lower than the predicted mean values, calculated by the L2 retrieval algorithm

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|--------------------|-------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 53 | | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | | |
| | | | | | | | Version 1.0 | | | |
| | | | | | | | 15/03/2024 | | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

CONCLUSIONS AND VALIDATION/

Comparisons are made with MIPAS and ACE

Good agreement with MIPAS. CFC11 has about a 10% low bias with respect to MIPAS earthwards of 70 hPa, and it increases to -50% spaceward toward 15-30 hPa.

The CFC11 comparisons with ACE are fairly consistent with those of MIPAS, showing a low bias of typically about <10% earthward of 30hPa. Notable differences in the ACE comparisons include: (i) a rapidly increasing HIRDLS high bias at northern high latitudes spaceward of 100hPa; (ii) a HIRDLS low bias of 10%-20% in the extra-tropical southern hemisphere; (iii) a spacewardly increasing high bias in the upper regions toward 20 hPa, rather than an increasing low bias seen in MIPAS comparisons

FILTERING AND DATA QUALITY

HIRDLS CFC measurements are generally useful between latitudes of 63 S to 80 N and within pressure ranges of 316 hPa –17.8 hPa (about 9 km to 28 km) for CFC11. It should be noted that data outside of the useful range has been eliminated from the publicly released data.

Use with caution the following:

- Data with negative precisions
- Data with cloud flag ≠ 0 - data should not be used
- CFC 11 data above surface value (approx. 250pptv).

Known Problems are reported in the README and Data Quality document.

DATA AVAILABILITY

HIRDLS data are available from several worldwide data repositories. In the United States, HIRDLS data can be downloaded from the Goddard Earth Sciences Data and Information Services Center (GES DISC) (<http://doi.org/10.5067/Aura/HIRDLS/DATA201>).

The data are stored in the version 5 Hierarchical Data Format for the Earth Observing System (HDF-EOS5), which is an extension of the HDF5 format. Each file contains a single swath object with one day of data (measured species and species precision), geolocation fields (e.g. time, latitude, longitude, pressure), and swath attributes, along with file level metadata. Each file contains approximately 5600 profile scans.

To cite the data in publications:

Gille, John and Gray, Lesley J. (2013), HIRDLS/Aura Level 2 Geophysical Parameters (on a pressure grid) V007, Greenbelt, MD, USA, Goddard Earth Sciences Data and Information Services Center (GES DISC), Accessed: [Data Access Date], 10.5067/Aura/HIRDLS/DATA201

| | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 54 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N2O | CFC | | | | HCFC | | HFC | CCI4 | SF6 |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

3.2 MIPAS-KIT/ENVISAT

| MIPAS-KIT CFC-11 products | |
|---------------------------------|---|
| <i>Product type</i> | VMR profile |
| <i>Level 2 processor</i> | KIT-IAA |
| <i>Data version</i> | L1b v8 L2 2002-2004: F-11_61 (NOM) L2 2005-2012: F-11_161 (UTLS1), F-11_261 (NOM), F-11_561 (MA) |
| <i>Reference</i> | https://doi.org/10.5194/amt-2023-172 |
| <i>Geometry</i> | limb |
| <i>Temporal coverage</i> | 2002-2012 |
| <i>Spatial coverage</i> | global |
| <i>Spatial resolution</i> | 300 km at 10-20 km, decreasing to 500 km at 60 km. |
| <i>Vertical resolution</i> | 2 km at tropopause, decreasing to 6 km at stratopause |
| <i>Useful vertical range</i> | 5-60 km |
| <i>Spectroscopic database</i> | HITRAN 2016 |
| <i>Spectral range</i> | CFC-11: 831-851 1/cm |
| <i>Product characterization</i> | Random and systematic error, vertical resolution and DOFs |
| <i>Data Format</i> | NetCDF |
| <i>Contact</i> | gabriele.stiller@kit.edu |
| <i>Data download</i> | https://www.imk-asf.kit.edu/english/308.php |
| <i>Recommendation</i> | Paper at References will be accepted soon and there will soon be an additional source for download of the data set (w/o registration). Papers at Validation refer to preceding data version. |

THE INSTRUMENT

Short description in [INSTRUMENTS → MIPAS short description](#)

DATA OVERVIEW

CONCLUSIONS AND VALIDATION

<https://doi.org/10.5194/essd-8-61-2016>

<https://doi.org/10.5194/amt-9-3355-2016>

FILTERING AND DATA QUALITY

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|-------------|--------------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | | Page 55 | |
| | OLLGHGs INVENTORY (URD) | | | | | | | | [D1.1] LOLIPOP_URD | |
| | | | | | | | | | Version 1.0 | |
| | | | | | | | | | 15/03/2024 | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

For valid data at a given altitude the data set entries 'visibility' and 'akm_diagonal' have to be equal to 1 and greater than 0.03, respectively, at that altitude..

DATA AVAILABILITY

Validation of previous version:

<https://doi.org/10.5194/essd-8-61-2016>

<https://doi.org/10.5194/essd-8-61-2016>

<https://doi.org/10.5194/amt-9-3355-2016>

| | | | | | | | | | |
|---|---|-----------|------------|-------------|-----------|-------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 56 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N2O | CFC | | | HCFC | | HFC | | CCI4 | SF6 |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

3.3 MIPAS-ESA/ENVISAT

| MIPAS-ESA CFC-11 products | |
|---------------------------------|--|
| <i>Product type</i> | VMR profile |
| <i>Level 2 processor</i> | Optimised Retrieval Model |
| <i>Data version</i> | L2 V8.22 |
| <i>Reference</i> | https://doi.org/10.5270/EN1-c8hgqx4 ; https://earth.esa.int/eogateway/documents/20142/37627/README_V8_issue_1.0_20201221.pdf |
| <i>Geometry</i> | Limb |
| <i>Temporal coverage</i> | 2002-2012 |
| <i>Spatial coverage</i> | Global |
| <i>Spatial resolution</i> | It depends on the meas. modes, around 400-500 km for NOM |
| <i>Vertical resolution</i> | About 4 km up to 30 km, slow degradation with altitude above |
| <i>Useful vertical range</i> | Full range reported in the output files |
| <i>Spectroscopic database</i> | Spectroscopic Database: HITRAN_mipas_pf4.45 is based on HITRAN08 (Rothman et al., 2009), but spectroscopic parameters for the molecules O2, SO2, OCS, CH3Cl, C2H2 and C2H6 are taken from HITRAN 2012 (Rothman et al., 2012). |
| <i>Spectral range</i> | Microwindows in 841.9-852.5 cm ⁻¹ |
| <i>Product characterization</i> | Random error (and CM), systematic error, AK |
| <i>Data Format</i> | NetCDF |
| <i>Contact</i> | Piera Raspollini |
| <i>Data download</i> | https://hm-atmos-ds.eo.esa.int/oads/access/collection/EnvisatMIPASL2PS |
| <i>Recommendation</i> | – |

THE INSTRUMENT

Short description in [INSTRUMENTS → MIPAS short description](#)

DATA OVERVIEW

The MIPAS level2-v8 database, along with the values of tangent pressures, temperatures, and VMR profiles of all the retrieved molecules, includes also some important products that can be used as diagnostic tools to characterise the quality of the reported results. Among them, the averaging kernels, the covariance matrices that map the random measurement noise onto the solution, and a few quality flags. All the products are stored in NetCDF files.

The L2 V8.22 dataset is described in: <https://doi.org/10.5194/amt-14-7975-2021>. The algorithm used for the reprocessing is described in: <https://doi.org/10.5194/amt-15-1871-2022>.

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 57 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| N2O | CFC | | | | HCFC | | HFC | | CCI4 | SF6 |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

CONCLUSIONS AND VALIDATION

The relative random error is 2-3% up to 100 hPa, then it rapidly increases also as a consequence of the reduction of the VMR.

Comparison with MIPAS balloon: deviations up to $\pm 10\%$ below 20 km; an increasing positive bias is visible above this altitude level.

FILTERING AND QUALITY FLAGGING

The quality of the retrieved profiles is determined on the basis of four criteria, two providing information on the successful convergence of the retrieval iterations, one on the capability of the retrieval to reproduce the measurements, and one on the presence of outliers in the retrieval error.

To provide an easy way to remove unreliable data, a final post-quality flag, summarising the outcome of the four quality criteria, is reported in the output files.

Take all profiles with `post_quality_flag=0`.

DATA AVAILABILITY

The data are available after registration at <https://doi.org/10.5270/EN1-c8hgqx4> (European Space Agency, 2021). The data download is free, after registration; utilisation of this data is subject to ESA's Earth Observation Terms and Conditions.

The information has been divided into two types of files: a standard one and an extended one. The standard files, one for each orbit and retrieved species, contain the information commonly required by the data users. Its filetype label is "2PS", and it is compliant with the Climate and Forecast convention (CF-1.6, Eaton et al., 2011) and with the Attribute Convention for Data Discovery (ACDD-1.3, ESIP, 2015). Extended files, identified by the filetype label "2PE", are also provided for each species and each orbit. They are "thought" for diagnostics and for advanced users, who need complete information about the retrieval process. This includes the full state vector (retrieved profiles, atmospheric continuum, and instrumental offset), along with the full CM and AKM, and additional information about the retrieval

| | | | | | | | | | |
|---|---|-----------|------------|-----------------------|-------------|-------------|--------------------|-------------|-----------------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 58 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N₂O | CFC | | | | HCFC | | HFC | CCI4 | SF₆ |
| | 11 | 12 | 113 | CF₄ | 22 | 142b | 23 | 134a | |

3.4 ACE-FTS/SciSat-1

| ACE-FTS CFC-11 products | |
|---------------------------------|---|
| <i>Product type</i> | VMR profile |
| <i>Level 2 processor</i> | |
| <i>Data version</i> | v5.2 |
| <i>Reference</i> | https://doi.org/10.1016/j.igsrt.2023.108749 |
| <i>Geometry</i> | Limb |
| <i>Temporal coverage</i> | February 2004 – present |
| <i>Spatial coverage</i> | 82 N – 82 S |
| <i>Spatial resolution</i> | |
| <i>Vertical resolution</i> | ~3 km (based on FOV of instrument), 1.5-6 km sampling |
| <i>Useful vertical range</i> | Varies with latitude, at Poles: 5 – 30 km; Equator: 5 – 35 km |
| <i>Spectroscopic database</i> | HITRAN 2020 |
| <i>Spectral range</i> | Microwindows in 832-862 cm ⁻¹ |
| <i>Product characterization</i> | Precision estimate provided at each altitude in profile |
| <i>Data Format</i> | netCDF |
| <i>Contact</i> | Kaley Walker |
| <i>Data download</i> | ACE-FTS data can be accessed at the following web portal: https://databace.scisat.ca/level2/ace_v5.2/display_data.php . First time data users can register at : https://databace.scisat.ca/l2signup.php Data quality flags provided separately at: https://doi.org/10.5683/SP3/NAYNFE |
| <i>Recommendation</i> | – |

THE INSTRUMENT

Short description in [INSTRUMENTS → ACE-FTS short description](#)

DATA OVERVIEW

The details of the current ACE-FTS processing version are in Boone et al. (2003) <https://doi.org/10.1016/j.igsrt.2023.108749>.

CONCLUSIONS AND VALIDATION/

v2.2+updates was validated by Mahieu et al. (2008) <https://doi.org/10.5194/acp-8-6199-2008>

v3.0 was compared to SLIMCAT output by Brown et al. (2011) <http://doi.org/10.5194/acpd-13-23491-2013>

v3.5 was validated by Eckert et al. (2016) <https://doi.org/10.5194/amt-9-3355-2016>

Work has been done on v4.1/4.2 and is being updated for v5.2.

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 59 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

FILTERING AND QUALITY FLAG

Data quality flags are provided for ACE-FTS v5.2 at <https://doi.org/10.5683/SP3/NAYNFE> based on the methodology described in Sheese et al. (2015) <https://doi.org/10.5194/amt-8-741-2015>

It is recommended to use data where flag = 0; profiles that include a flag value of 4 or 5 can also be filtered out, except when data set contains realistic sporadic enhancements. Always look at rejected data to ensure that physically realistic data are not being filtered out. Some datasets will require further filtering.

DATA AVAILABILITY

Available online. Access to Level 2 data after registration

| | | | | | | | | | |
|---|---|-----------|------------|-----------------------|-------------|-------------|--------------------|------------------------|-----------------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 60 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N₂O | CFC | | | | HCFC | | HFC | CCl₄ | SF₆ |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF₄</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

3.5 ILAS II/ADEOS II

| ILAS-II CFC-11 products | |
|---------------------------------|---|
| <i>Product type</i> | VMR profiles |
| <i>Level 2 processor</i> | |
| <i>Data version</i> | V3.0 |
| <i>Reference</i> | |
| <i>Geometry</i> | Limb |
| <i>Temporal coverage</i> | Jan 2003-Oct 2003 (1 profile per ~100 min in each hemisphere) |
| <i>Spatial coverage</i> | 56-70 °N and 63-88 °S |
| <i>Spatial resolution</i> | The instantaneous field of view at the tangent height (TH) has a 1 km height in the vertical direction and a 13 km width in the horizontal direction for the infrared channel. Latitude: Depends on season; Longitude: ~25 degrees Vertical: 1.3-2.9 km at tangent heights of 15-55 km |
| <i>Vertical sampling</i> | 1 km between 5 and 60 km |
| <i>Useful vertical range</i> | |
| <i>Spectroscopic database</i> | HITRAN 2004 |
| <i>Spectral range</i> | |
| <i>Product characterization</i> | Error (internal and total error as described in Sect.6 of https://doi.org/10.1029/2001JD000628) |
| <i>Data Format</i> | Ascii NASA Ames Format 2160 https://espoarchive.nasa.gov/content/Ames_Format_Specificatio_n_v20 |
| <i>Contact</i> | tsugita@nies.go.jp |
| <i>Data download</i> | https://db.cger.nies.go.jp/DL/10.17595/20180628.004.html.en |
| <i>Recommendation</i> | |

THE INSTRUMENT

Short description in [INSTRUMENTS → ILAS II short description](#)

DATA OVERVIEW

CONCLUSIONS AND VALIDATION/

No validation papers for V3. V2 was validated with MIPAS:

<https://acp.copernicus.org/articles/8/825/2008/acp-8-825-2008.pdf>

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|--------------------|-------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 61 | | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | | |
| | | | | | | | Version 1.0 | | | |
| | | | | | | | 15/03/2024 | | | |
| N2O | CFC | | | | HCFC | | HFC | | CCI4 | SF6 |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

FILTERING AND DATA QUALITY

To select only data characterised by: 'Data quality: GOOD'. This means that all of the 44 spectral channels are in good condition.

DATA AVAILABILITY

In the web page <https://db.cger.nies.go.jp/DL/10.17595/20180628.004.html.en> it is possible to download separately two tar.gz files for the Sunrise and the Sunset measurements. When untaring there are 2 directories: V03.00 and V03.01

v3.01 is just acquired by AC (alternating current) mode, v3.00 is DC mode, with AC and DC being the two different mode data acquisitions (Nakajima et al., 2006). Since there is no difference between the data products as measured exclusively with the two modes, it is seamless to handle both of the branch numbers in data versions , e.g., 3.00 (DC mode) and 3.01 (AC mode).

Please refer Yokota's unpublished v1.4 draft paper from:

<https://www.nies.go.jp/doi/10.17595/20180628.004-e.html>

Acknowledgements.

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Citation format: When this data set is referred to in publications, it should be cited in the following format.

Sugita, T., H. Nakajima, and T. Yokota (2018), Improved Limb Atmospheric Spectrometer-II (ILAS-II), Version 3.0, Center for Global Environmental Research, NIES, DOI:10.17595/20180628.004. (Reference date*: YYYY/MM/DD)

* As the reference date, please indicate the date you downloaded the files.

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 62 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCl4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

3.6 ATMOS/Space Shuttle

For CFC-11 profiles from ATMOS measurements see Section 2.9.

All retrieved species are provided in the same files.

3.7 CLAES/UARS

For CFC-11 profiles from CLAES measurements see Section 2.10.

All retrieved species are provided in the same files.

3.8 CRISTA/Space Shuttle

For CFC-11 profiles from CRISTA measurements see Section 2.12.

| | | | | | | | | | |
|---|---|-----------|------------|-----------------------|-------------|-------------|--------------------|------------------------|-----------------------|
|  | ESA Climate Change Initiative “Plus” (CCI+) | | | | | | Page 63 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N₂O | CFC | | | | HCFC | | HFC | CCl₄ | SF₆ |
| | 11 | 12 | 113 | CF₄ | 22 | 142b | 23 | 134a | |

3.9 IASI/MetOp

| IASI CFC-11 products | |
|---------------------------------|--|
| <i>Product type</i> | Total column |
| <i>Level 2 processor</i> | |
| <i>Data version</i> | V0 |
| <i>Reference</i> | De Longueville et al., 2023 (https://doi.org/10.1016/j.jqsrt.2023.108755) |
| <i>Geometry</i> | nadir |
| <i>Temporal coverage</i> | 2008-2023 |
| <i>Spatial coverage</i> | currently only 23.27°N—66.32°N |
| <i>Spatial resolution</i> | average over all region |
| <i>Vertical resolution</i> | Total column |
| <i>Useful vertical range</i> | 0-40 km |
| <i>Spectroscopic database</i> | |
| <i>Spectral range</i> | 800-900 cm ⁻¹ |
| <i>Product characterization</i> | |
| <i>Data Format</i> | tbd |
| <i>Contact</i> | simon.whitburn@ulb.be; pierre.coheur@ulb.be |
| <i>Data download</i> | Available at ULB on request |
| <i>Recommendation</i> | Data to be extended globally but still on spatially averaged regions. Absolute column retrievals under investigation. |

THE INSTRUMENT

Short description in [INSTRUMENTS → IASI short description](#)

DATA OVERVIEW

Monthly concentration in the period between 2008 and 2022, retrieved by using an unconstrained generalized least squares estimation retrieval methodology, which largely allows to overcome the problem of interference.

More details in De Longueville et al., 2023 (<https://doi.org/10.1016/j.jqsrt.2023.108755>).

CONCLUSIONS AND VALIDATION

Trends are compared to the observations from AGAGE and ACE-FTS. A good match is obtained with both, with especially remarkable agreement in the linear trends for CF₄, SF₆ and HFC-134a, and in the non-linear trends of CFC-11 and HCFC-22.

More details in De Longueville et al., 2023 (<https://doi.org/10.1016/j.jqsrt.2023.108755>).

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 64 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

FILTERING AND DATA QUALITY

cloud flag = 0; viewing angle < 15°.

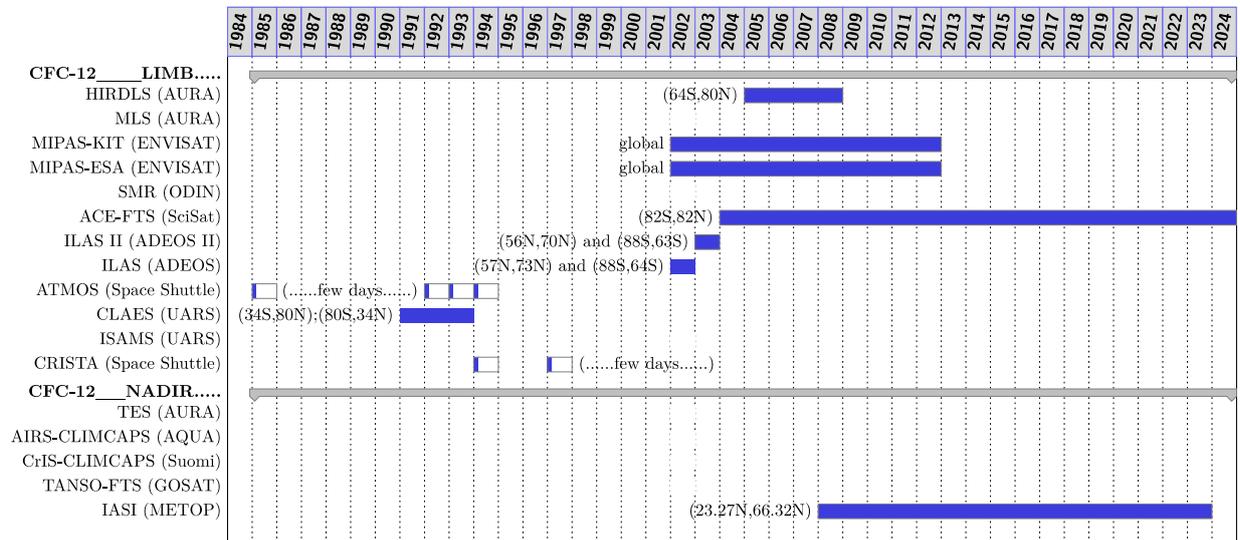
DATA AVAILABILITY

Data will be made available on request.

| | | | | | | | | | | |
|---|---|-----------|--------------------|------------|-------------|-------------|------------|-------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | Page 65 | | | | | | | |
| | OLLGHGs INVENTORY | | [D1.1] LOLIPOP_URD | | | | | | | |
| | (URD) | | Version 1.0 | | | | | | | |
| | | | 15/03/2024 | | | | | | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

4 CFC-12

| INSTRUMENT SELECTOR | | | |
|---------------------|------------------|-------------|------------------|
| <i>LIMB</i> | <u>HIRDLS</u> | --- | <u>MIPAS-KIT</u> |
| | <u>MIPAS-ESA</u> | --- | <u>ACE-FTS</u> |
| | <u>ILAS II</u> | <u>ILAS</u> | <u>ATMOS</u> |
| | <u>CLAES</u> | --- | <u>CRISTA</u> |
| <i>NADIR</i> | --- | --- | --- |
| | --- | <u>IASI</u> | --- |
| | --- | --- | --- |



| | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 66 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

4.1 HIRDLS/AURA

| HIRDLS CFC-12 products | |
|---------------------------------|---|
| <i>Product type</i> | VMR profile |
| <i>Level 2 processor</i> | |
| <i>Data version</i> | L2 V7 |
| <i>Reference</i> | https://docserver.gesdisc.eosdis.nasa.gov/repository/Mission/HIRDLS/3.3_Product_Documentation/3.3.5_Product_Quality/HIRDLS-DQD_V7.pdf |
| <i>Geometry</i> | limb |
| <i>Temporal coverage</i> | January 29, 2005 - March 17, 2008. |
| <i>Spatial coverage</i> | +80 to -64 degrees latitude |
| <i>Spatial resolution</i> | 100 km along an orbit track with an orbital separation of about 24 degrees of longitude (about 2000 km at 40N) |
| <i>Vertical resolution</i> | 1.0-1.2 km km |
| <i>Useful vertical range</i> | CFC12 316 hPa – 8.3 hPa |
| <i>Spectroscopic database</i> | |
| <i>Spectral range</i> | 21 channels ranging from 6.12 to 17.76 microns |
| <i>Product characterization</i> | Estimated precision |
| <i>Data Format</i> | HDF-EOS5 |
| <i>Contact</i> | Bruno Nardi |
| <i>Data download</i> | https://disc.gsfc.nasa.gov/datasets/HIRDLS2_007/summary?keywords=HIRDLS |
| <i>Recommendation</i> | – |

*Information extracted from the README and Data Quality document:
"High Resolution Dynamics Limb Sounder Earth Observing System (EOS) Data Description and
Quality Version 7 (V7) (HIRDLS Version 7.00.00) June, 2013"*

THE INSTRUMENT

Short description in [INSTRUMENTS → HIRDLS short description](#)

DATA OVERVIEW

The "HIRDLS/Aura Level 2 Geophysical Parameters" data product (HIRDLS2) contains an entire day's worth of Level-2 vertical profiles of O3, HNO3, H2O, CFC-11, CFC-12, N2O, NO2, N2O5, ClONO2, temperature, geopotential height, and aerosol extinction at 12.1 and 8.3 microns, as well as cloud top pressure.

The precision estimated from the average of 10 sets of 12 sequential profiles in undisturbed regions indicates precisions of 0.02-0.05 ppbv (5%-10%) for CFC12., lower than the predicted mean values, calculated by the L2 retrieval algorithm

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|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 67 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N2O | CFC | | | | HCFC | | HFC | CCI4 | SF6 |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

CONCLUSIONS AND VALIDATION/

Comparisons are made with MIPAS and ACE

Good agreement with MIPAS. CFC12 has a bias generally within $\pm 5\%$ of the MIPAS values earthwards of 40 hPa. Spaceward toward 10hPa, the CFC12 bias increases to +50% in the tropics and in the southern hemisphere spaceward, and to -50% in the northern extratropics.

CFC12 comparisons with ACE have similar commonalities and inconsistencies with MIPAS comparisons as seen with CFC11. The typical HIRDLS CFC12 bias is often 1-2%, similar to the $<\pm 5\%$ bias seen with MIPAS comparisons. There is also a greater high bias ($\sim 10\%$) near 50 hPa at northern high latitudes. However, as with CFC11, the bias in the upper regions tends to amplify to an increased high bias (toward 10 hPa) at all latitudes, in contrast with the low bias seen in northern high latitudes in the MIPAS comparisons.

FILTERING AND DATA QUALITY

HIRDLS CFC measurements are generally useful between latitudes of 63 S to 80 N and within pressure ranges of 316 hPa –8.3 hPa (about 9 km to 35 km) for CFC12. It should be noted that data outside of the useful range has been eliminated from the publicly released data.

Use with caution the following:

- Data with negative precisions
- Data with cloud flag $\neq 0$ - data should not be used
- CFC 12 data above surface value (approx. 540pptv)

Known Problems are reported in the README and Data Quality document.

DATA AVAILABILITY

HIRDLS data are available from several worldwide data repositories. In the United States, HIRDLS data can be downloaded from the Goddard Earth Sciences Data and Information Services Center (GES DISC) (<http://doi.org/10.5067/Aura/HIRDLS/DATA201>).

The data are stored in the version 5 Hierarchical Data Format for the Earth Observing System (HDF-EOS5), which is an extension of the HDF5 format. Each file contains a single swath object with one day of data (measured species and species precision), geolocation fields (e.g. time, latitude, longitude, pressure), and swath attributes, along with file level metadata. Each file contains approximately 5600 profile scans.

To cite the data in publications:

Gille, John and Gray, Lesley J. (2013), HIRDLS/Aura Level 2 Geophysical Parameters (on a pressure grid) V007, Greenbelt, MD, USA, Goddard Earth Sciences Data and Information Services Center (GES DISC), Accessed: [Data Access Date], 10.5067/Aura/HIRDLS/DATA201

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| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N2O | CFC | | | | HCFC | | HFC | CCI4 | SF6 |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

4.2 MIPAS-KIT/ENVISAT

| MIPAS-KIT CFC-12 products | |
|---------------------------------|---|
| <i>Product type</i> | VMR profile |
| <i>Level 2 processor</i> | KIT-IAA |
| <i>Data version</i> | L1b v8 L2 2002-2004: F-12_61 (NOM) L2 2005-2012: F-12_161 (UTLS1), F-12_261 (NOM), F-12_561 (MA) |
| <i>Reference</i> | https://doi.org/10.5194/amt-2023-172 |
| <i>Geometry</i> | limb |
| <i>Temporal coverage</i> | 2002-2012 |
| <i>Spatial coverage</i> | global |
| <i>Spatial resolution</i> | 300 km at 10-20 km, decreasing to 500 km at 60 km. |
| <i>Vertical resolution</i> | 2 km at tropopause, decreasing to 6 km at stratopause |
| <i>Useful vertical range</i> | 5- 50 km |
| <i>Spectroscopic database</i> | HITRAN 2016 |
| <i>Spectral range</i> | CFC-12: 915-925 1/cm & 1150-1165 1/cm |
| <i>Product characterization</i> | Random and systematic error, vertical resolution and DOFs |
| <i>Data Format</i> | NetCDF |
| <i>Contact</i> | gabriele.stiller@kit.edu |
| <i>Data download</i> | https://www.imk-asf.kit.edu/english/308.php |
| <i>Recommendation</i> | Paper at References will be accepted soon and there will soon be an additional source for download of the data set (w/o registration). Papers at Validation refer to preceding data version. |

THE INSTRUMENT

Short description in [INSTRUMENTS → MIPAS short description](#)

DATA OVERVIEW

CONCLUSIONS AND VALIDATION

<https://doi.org/10.5194/essd-8-61-2016>

<https://doi.org/10.5194/amt-9-3355-2016>

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|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 69 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

FILTERING AND DATA QUALITY

For valid data at a given altitude the data set entries 'visibility' and 'akm_diagonal' have to be equal to 1 and greater than 0.03, respectively, at that altitude..

DATA AVAILABILITY

Validation of previous version:

<https://doi.org/10.5194/essd-8-61-2016>

<https://doi.org/10.5194/essd-8-61-2016>

<https://doi.org/10.5194/amt-9-3355-2016>

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|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 70 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N2O | CFC | | | | HCFC | | HFC | CCI4 | SF6 |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

4.3 MIPAS-ESA/ENVISAT

| MIPAS-ESA CFC-12 products | |
|---------------------------------|--|
| <i>Product type</i> | VMR profile |
| <i>Level 2 processor</i> | Optimised Retrieval Model |
| <i>Data version</i> | L2 V8.22 |
| <i>Reference</i> | https://doi.org/10.5270/EN1-c8hgqx4 ; https://earth.esa.int/eogateway/documents/20142/37627/REA_DME_V8_issue_1.0_20201221.pdf |
| <i>Geometry</i> | Limb |
| <i>Temporal coverage</i> | 2002-2012 |
| <i>Spatial coverage</i> | Global |
| <i>Spatial resolution</i> | It depends on the meas. modes, around 400-500 km for NOM |
| <i>Vertical resolution</i> | It varies from 5 km at 6 km to 7.5 at 40 km for both FR and OR measurements |
| <i>Useful vertical range</i> | Full range as reported in the output files |
| <i>Spectroscopic database</i> | Spectroscopic Database: HITRAN_mipas_pf4.45 is based on HITRAN08 (Rothman et al., 2009), but spectroscopic parameters for the molecules O2, SO2, OCS, CH3Cl, C2H2 and C2H6 are taken from HITRAN 2012 (Rothman et al., 2012). |
| <i>Spectral range</i> | Microwindows in 857.5-940.0625 & 1159.875-1162.85 cm ⁻¹ |
| <i>Product characterization</i> | Random error (and CM), systematic error, AK |
| <i>Data Format</i> | NetCDF |
| <i>Contact</i> | Piera Raspollini |
| <i>Data download</i> | https://hm-atmos-ds.eo.esa.int/oads/access/collection/EnvisatMIPASL2PS |
| <i>Recommendation</i> | - |

THE INSTRUMENT

Short description in [INSTRUMENTS → MIPAS short description](#)

DATA OVERVIEW

The MIPAS level2-v8 database, along with the values of tangent pressures, temperatures, and VMR profiles of all the retrieved molecules, includes also some important products that can be used as diagnostic tools to characterise the quality of the reported results. Among them, the averaging kernels, the covariance matrices that map the random measurement noise onto the solution, and a few quality flags. All the products are stored in NetCDF files.

The L2 V8.22 dataset is described in: <https://doi.org/10.5194/amt-14-7975-2021>. The algorithm used for the reprocessing is described in: <https://doi.org/10.5194/amt-15-1871-2022>.

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|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 71 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N2O | CFC | | | | HCFC | | HFC | CCI4 | SF6 |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

CONCLUSIONS AND VALIDATION

The random error is approximately constant and equal to 5% up to 40 hPa (22 km), up to 20 hPa (28 km) for equatorial atmosphere, then it rapidly increases.

More details about product validation can be found in: Wetzel et al., 2022 (<https://doi.org/10.5194/amt-15-6669-2022>)

and in the Readme file:

(https://earth.esa.int/eogateway/documents/20142/37627/README_V8_issue_1.0_20201221.pdf)

FILTERING AND QUALITY FLAGGING

The quality of the retrieved profiles is determined on the basis of four criteria, two providing information on the successful convergence of the retrieval iterations, one on the capability of the retrieval to reproduce the measurements, and one on the presence of outliers in the retrieval error.

To provide an easy way to remove unreliable data, a final post-quality flag, summarising the outcome of the four quality criteria, is reported in the output files.

Take all profiles with `post_quality_flag=0`.

DATA AVAILABILITY

The data are available after registration at <https://doi.org/10.5270/EN1-c8hgqx4> (European Space Agency, 2021). The data download is free, after registration; utilisation of this data is subject to ESA's Earth Observation Terms and Conditions.

The information has been divided into two types of files: a standard one and an extended one. The standard files, one for each orbit and retrieved species, contain the information commonly required by the data users. Its filetype label is "2PS", and it is compliant with the Climate and Forecast convention (CF-1.6, Eaton et al., 2011) and with the Attribute Convention for Data Discovery (ACDD-1.3, ESIP, 2015). Extended files, identified by the filetype label "2PE", are also provided for each species and each orbit. They are "thought" for diagnostics and for advanced users, who need complete information about the retrieval process. This includes the full state vector (retrieved profiles, atmospheric continuum, and instrumental offset), along with the full CM and AKM, and additional information about the retrieval.

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|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 72 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N2O | CFC | | | HCFC | | HFC | | CCI4 | SF6 |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

4.4 ACE-FTS/SciSat-1

| ACE-FTS CFC-12 products | |
|---------------------------------|---|
| <i>Product type</i> | VMR profile |
| <i>Level 2 processor</i> | |
| <i>Data version</i> | v5.2 |
| <i>Reference</i> | https://doi.org/10.1016/j.igsrt.2023.108749 |
| <i>Geometry</i> | Limb |
| <i>Temporal coverage</i> | February 2004 – present |
| <i>Spatial coverage</i> | 82 N – 82 S |
| <i>Spatial resolution</i> | |
| <i>Vertical resolution</i> | ~3 km (based on FOV of instrument), 1.5-6 km sampling |
| <i>Useful vertical range</i> | Varies with latitude, at Poles: 5 – 30 km; Equator: 5 – 35 km |
| <i>Spectroscopic database</i> | HITRAN 2020 |
| <i>Spectral range</i> | Microwindows in 919-942 cm ⁻¹ and 1158-1162 cm ⁻¹ |
| <i>Product characterization</i> | Precision estimate provided at each altitude in profile |
| <i>Data Format</i> | netCDF |
| <i>Contact</i> | Kaley Walker |
| <i>Data download</i> | ACE-FTS data can be accessed at the following web portal: https://databace.scisat.ca/level2/ace_v5.2/display_data.php . First time data users can register at https://databace.scisat.ca/l2signup.php Data quality flags provided separately at: https://doi.org/10.5683/SP3/NAYNFE |
| <i>Recommendation</i> | – |

THE INSTRUMENT

Short description in [INSTRUMENTS → ACE-FTS short description](#)

DATA OVERVIEW

The details of the current ACE-FTS processing version are in Boone et al. (2003) <https://doi.org/10.1016/j.igsrt.2023.108749>.

CONCLUSIONS AND VALIDATION/

v2.2+updates was validated by Mahieu et al. (2008) <https://doi.org/10.5194/acp-8-6199-2008>

v3.0 was compared to SLIMCAT output by Brown et al. (2011) <http://doi.org/10.5194/acpd-13-23491-2013>

v3.5 was validated by Eckert et al. (2016) <https://doi.org/10.5194/amt-9-3355-2016>

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|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 73 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

Work has been done on v4.1/4.2 and is being updated for v5.2.

FILTERING AND QUALITY FLAGGING

Data quality flags are provided for ACE-FTS v5.2 at <https://doi.org/10.5683/SP3/NAYNFE> based on the methodology described in Sheese et al. (2015) <https://doi.org/10.5194/amt-8-741-2015>

It is recommended to use data where flag = 0; profiles that include a flag value of 4 or 5 can also be filtered out, except when data set contains realistic sporadic enhancements. Always look at rejected data to ensure that physically realistic data are not being filtered out. Some datasets will require further filtering.

DATA AVAILABILITY

Available online. Access to Level 2 data after registration

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|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 74 | | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | | |
| | | | | | | | Version 1.0 | | | |
| | | | | | | | 15/03/2024 | | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

4.5 ILAS II/ADEOS II

| ILAS-II CFC-12 products | |
|---------------------------------|--|
| <i>Product type</i> | VMR profiles |
| <i>Level 2 processor</i> | |
| <i>Data version</i> | V3.0 |
| <i>Reference</i> | |
| <i>Geometry</i> | Limb |
| <i>Temporal coverage</i> | Jan 2003-Oct 2003 (1 profile per ~100 min in each hemisphere) |
| <i>Spatial coverage</i> | 56-70 °N and 63-88 °S |
| <i>Spatial resolution</i> | The instantaneous field of view at the tangent height (TH) has a 1 km height in the vertical direction and a 13 km width in the horizontal direction for the infrared channel. Latitude: Depends on season Longitude: ~25 degrees Vertical: 1.3-2.9 km at tangent heights of 15-55 km |
| <i>Vertical sampling</i> | 1 km between 5 and 60 km |
| <i>Useful vertical range</i> | |
| <i>Spectroscopic database</i> | HITRAN 2004 |
| <i>Spectral range</i> | |
| <i>Product characterization</i> | Error (internal and total error as described in Sect.6 of https://doi.org/10.1029/2001JD000628) |
| <i>Data Format</i> | Ascii NASA Ames Format 2160 https://espoarchive.nasa.gov/content/Ames_Format_Specification_v20 |
| <i>Contact</i> | tsugita@nies.go.jp |
| <i>Data download</i> | https://db.cger.nies.go.jp/DL/10.17595/20180628.004.html.en |
| <i>Recommendation</i> | |

THE INSTRUMENT

Short description in [INSTRUMENTS → ILAS II short description](#)

DATA OVERVIEW

CONCLUSIONS AND VALIDATION/

No validation papers for V3. V2 was validated with MIPAS:

<https://acp.copernicus.org/articles/8/825/2008/acp-8-825-2008.pdf>

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|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 75 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

FILTERING AND DATA QUALITY

To select only data characterised by: 'Data quality: GOOD'. This means that all of the 44 spectral channels are in good condition.

DATA AVAILABILITY

In the web page <https://db.cger.nies.go.jp/DL/10.17595/20180628.004.html.en> it is possible to download separately two tar.gz files for the Sunrise and the Sunset measurements. When untaring there are 2 directories: V03.00 and V03.01

v3.01 is just acquired by AC (alternating current) mode, v3.00 is DC mode, with AC and DC being the two different mode data acquisitions (Nakajima et al., 2006). Since there is no difference between the data products as measured exclusively with the two modes, it is seamless to handle both of the branch numbers in data versions , e.g., 3.00 (DC mode) and 3.01 (AC mode).

Please refer Yokota's unpublished v1.4 draft paper from:
<https://www.nies.go.jp/doi/10.17595/20180628.004-e.html>

ACKNOWLEDGEMENTS.

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Citation format: When this data set is referred to in publications, it should be cited in the following format.

Sugita, T., H. Nakajima, and T. Yokota (2018), Improved Limb Atmospheric Spectrometer-II (ILAS-II), Version 3.0, Center for Global Environmental Research, NIES, [DOI:10.17595/20180628.004](https://doi.org/10.17595/20180628.004). (Reference date*: YYYY/MM/DD)

* As the reference date, please indicate the date you downloaded the files.

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|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 76 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N₂O | CFC | | | | HCFC | | HFC | CCl₄ | SF₆ |
| | 11 | 12 | 113 | CF₄ | 22 | 142b | 23 | 134a | |

4.6 ILAS/ADEOS

| ILAS products | CFC-12 |
|---------------------------------|--|
| <i>Product type</i> | VMR profiles |
| <i>Level 2 processor</i> | onion-peeling method and nonlinear least squares fitting |
| <i>Data version</i> | V06.10 |
| <i>Reference</i> | https://db.cger.nies.go.jp/ilas_pub/reference/Sugita_2005_ILAS_v6_tech_report.pdf https://db.cger.nies.go.jp/MD/10.17595/20180628.001.html.en |
| <i>Geometry</i> | Limb |
| <i>Temporal coverage</i> | 18.09.1996-29.06.1997 (processed on 21.10.2005) |
| <i>Product type</i> | VMR profiles |
| <i>Spatial resolution</i> | Northern Hemisphere] Latitude: 57° ~ 73°, Longitude: -180° ~ 180°; [Southern Hemisphere] Latitude: -64° ~ -88°, Longitude: -180° ~ 180° |
| <i>Vertical resolution</i> | Vertical: 1.9-3.5 km at tangent heights of 15-55 km |
| <i>Useful vertical range</i> | Vertical: ~10 km - 70 km |
| <i>Spectral range</i> | an infrared spectrometer (between 6.21 μm to 11.77 μm) and a visible spectrometer (between 753 nm and 784 nm). |
| <i>Product characterization</i> | Error (internal and total error as described in Sect.6 of https://doi.org/10.1029/2001JD000628) |
| <i>Data Format</i> | Ascii NASA Ames Format 2160 https://espoarchive.nasa.gov/content/Ames_Format_Specification_v20 |
| <i>Contact</i> | tsugita@nies.go.jp |
| <i>Data download</i> | https://db.cger.nies.go.jp/DL/10.17595/20180628.001.html.en |
| <i>Recommendation</i> | |

THE INSTRUMENT

Short description in [INSTRUMENTS → ILAS short description](#)

DATA OVERVIEW

CONCLUSIONS AND VALIDATION/

CFC-12 (and CIONO 2) data are newly added to the Version 6 data set. The characteristics of Version 6 CFC-12 and CIONO2 data are well evaluated in Khosrawi et al., 2004 (doi:10.1029/2003JD004325).

Low relative differences between ILAS CFC-12 and the correlative measurements of about 10% were found between 13 and 20 km. The comparison of vertical profiles shows that ILAS

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| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | | |
| | | | | | | | Version 1.0 | | | |
| | | | | | | | 15/03/2024 | | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCl4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

CFC-12 data are useful below about 20–22 km inside the vortex and below about 25 km outside the vortex. However, at greater altitudes the relative percentage difference increases very strongly with increasing altitude.

FILTERING

To select only data characterised by: ‘Data quality: GOOD’. This means that all of the 44 spectral channels are in good condition.

DATA AVAILABILITY

In the web page <https://db.cger.nies.go.jp/DL/10.17595/20180628.004.html.en> it is possible to download one tar.gz file for each trace species which include both the Sunrise and the Sunset measurements. When untaring there is one file for each retrieved profile, relative either to sunset or sunrise, as indicated in the name of the file,

ACKNOWLEDGEMENTS.

When this data set is referred to in publications, it should be cited in the following format:

Sugita, T., H. Nakajima, and T. Yokota (2018), Improved Limb Atmospheric Spectrometer (ILAS), Version 6.1, Center for Global Environmental Research, NIES, [DOI:10.17595/20180628.001](https://doi.org/10.17595/20180628.001). (Reference date*: YYYY/MM/DD). * As the reference date, please indicate the date you downloaded the files.

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 78 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCl4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

4.7 ATMOS

For CFC-12 profiles from ATMOS measurements see Sect. 2.9.

All retrieved species are provided in the same files.

4.8 CLAES/UARS

For CFC-12 profiles from CLAES measurements see Sect.2.10.

All retrieved species are provided in the same files.

4.9 CRISTA/Space Shuttle

For CFC-11 profiles from CRISTA measurements see Section 2.12.

All retrieved species are provided in the same files.

| | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative “Plus” (CCI+) | | | | | | Page 79 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N2O | CFC | | | | HCFC | | HFC | CCI4 | SF6 |
| | 11 | 12 | 113 | CF4 | 22 | 142b | 23 | 134a | |

4.10 IASI/MetOp

| IASI CFC-12 products | |
|---------------------------------|--|
| <i>Product type</i> | Total column |
| <i>Level 2 processor</i> | |
| <i>Data version</i> | V0 |
| <i>Reference</i> | De Longueville et al., 2023 (https://doi.org/10.1016/j.jqsrt.2023.108755) |
| <i>Geometry</i> | nadir |
| <i>Temporal coverage</i> | 2008-2023 |
| <i>Spatial coverage</i> | currently only 23.27°N—66.32°N |
| <i>Spatial resolution</i> | average over all region |
| <i>Vertical resolution</i> | Total column |
| <i>Useful vertical range</i> | 0-40 km |
| <i>Spectroscopic database</i> | |
| <i>Spectral range</i> | 900-940 cm ⁻¹ |
| <i>Product characterization</i> | |
| <i>Data Format</i> | tbd |
| <i>Contact</i> | simon.whitburn@ulb.be; pierre.coheur@ulb.be |
| <i>Data download</i> | Available at ULB |
| <i>Recommendation</i> | Data to be extended globally but still on spatially averaged regions. Absolute column retrievals under investigation. |

THE INSTRUMENT

Short description in [INSTRUMENTS → IASI short description](#)

DATA OVERVIEW

Monthly concentration in the period between 2008 and 2022, retrieved by using an unconstrained generalized least squares estimation retrieval methodology, which largely allows to overcome the problem of interference.

More details in De Longueville et al., 2023 (<https://doi.org/10.1016/j.jqsrt.2023.108755>).

CONCLUSIONS AND VALIDATION

Trends are compared to the observations from AGAGE and ACE-FTS. A good match is obtained with both, with especially remarkable agreement in the linear trends for CF4, SF6 and HFC-134a, and in the non-linear trends of CFC-11 and HCFC-22.

Large discrepancies and unexplained variations are seen in the time series of HCFC-142b, CFC-12 and CCI4, necessitating further optimization of the retrieval technique

More details in De Longueville et al., 2023 (<https://doi.org/10.1016/j.jqsrt.2023.108755>).

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 80 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

FILTERING AND DATA QUALITY

cloud flag = 0; viewing angle < 15°.

DATA AVAILABILITY

Data will be made available on request.

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 81 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | 15/03/2024 | | | | | | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

5 CFC-113

| INSTRUMENT SELECTOR | | | |
|---------------------|-----|-----|----------------|
| <i>LIMB</i> | --- | --- | --- |
| | --- | --- | <u>ACE-FTS</u> |
| | --- | --- | --- |
| | --- | --- | --- |
| <i>NADIR</i> | --- | --- | --- |
| | --- | --- | --- |
| | --- | --- | --- |

| | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 |
|------------------------|-------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| CFC-113__LIMB..... | ----- | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| HIRDLS (AURA) | ----- | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MLS (AURA) | ----- | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MIPAS-KIT (ENVISAT) | ----- | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MIPAS-ESA (ENVISAT) | ----- | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SMR (ODIN) | ----- | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ACE-FTS (SciSat) | ----- | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ILAS II (ADEOS II) | ----- | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ILAS (ADEOS) | ----- | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ATMOS (Space Shuttle) | ----- | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| CLAES (UARS) | ----- | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ISAMS (UARS) | ----- | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| CRISTA (Space Shuttle) | ----- | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| CFC-113__NADIR..... | ----- | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TES (AURA) | ----- | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| AIRS-CLIMCAPS (AQUA) | ----- | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| CrIS-CLIMCAPS (Suomi) | ----- | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TANSO-FTS (GOSAT) | ----- | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| IASI (METOP) | ----- | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 82 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N2O | CFC | | | | HCFC | | HFC | CCI4 | SF6 |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

5.1 ACE-FTS

| ACE-FTS CFC-113 products | |
|---------------------------------|--|
| <i>Product type</i> | VMR profile |
| <i>Level 2 processor</i> | |
| <i>Data version</i> | v5.2 |
| <i>Reference</i> | https://doi.org/10.1016/j.jqsrt.2023.108749 |
| <i>Geometry</i> | Limb |
| <i>Temporal coverage</i> | February 2004 - present |
| <i>Spatial coverage</i> | 82 N – 82 S |
| <i>Spatial resolution</i> | |
| <i>Vertical resolution</i> | ~3 km (based on FOV of instrument), 1.5-6 km sampling |
| <i>Useful vertical range</i> | 5 -25 km |
| <i>Spectroscopic database</i> | HITRAN 2020 |
| <i>Spectral range</i> | Microwindows in 1094-1123 cm ⁻¹ |
| <i>Product characterization</i> | Precision estimate provided at each altitude in profile |
| <i>Data Format</i> | netCDF |
| <i>Contact</i> | Kaley Walker |
| <i>Data download</i> | ACE-FTS data can be accessed at the following web portal: https://databace.scisat.ca/level2/ace_v5.2/display_data.php . First time data users can register at https://databace.scisat.ca/l2signup.php . Data quality flags provided separately at: https://doi.org/10.5683/SP3/NAYNFE |
| <i>Recommendation</i> | – |

THE INSTRUMENT

Short description in [INSTRUMENTS → ACE-FTS short description](#)

DATA OVERVIEW

The details of the current ACE-FTS processing version are in Boone et al. (2003) [HYPERLINK "https://doi.org/10.1016/j.jqsrt.2023.108749"](https://doi.org/10.1016/j.jqsrt.2023.108749) <https://doi.org/10.1016/j.jqsrt.2023.108749>.

CONCLUSIONS AND VALIDATION

v3.0 was compared to SLIMCAT output by Brown et al. (2011) <http://doi.org/10.5194/acpd-13-23491-2013>

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 83 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

FILTERING AND DATA QUALITY

Data quality flags are provided for ACE-FTS v5.2 at <https://doi.org/10.5683/SP3/NAYNFE> based on the methodology described in Sheese et al. (2015) <https://doi.org/10.5194/amt-8-741-2015>

It is recommended to use data where flag = 0; profiles that include a flag value of 4 or 5 can also be filtered out, except when data set contains realistic sporadic enhancements. Always look at rejected data to ensure that physically realistic data are not being filtered out. Some datasets will require further filtering.

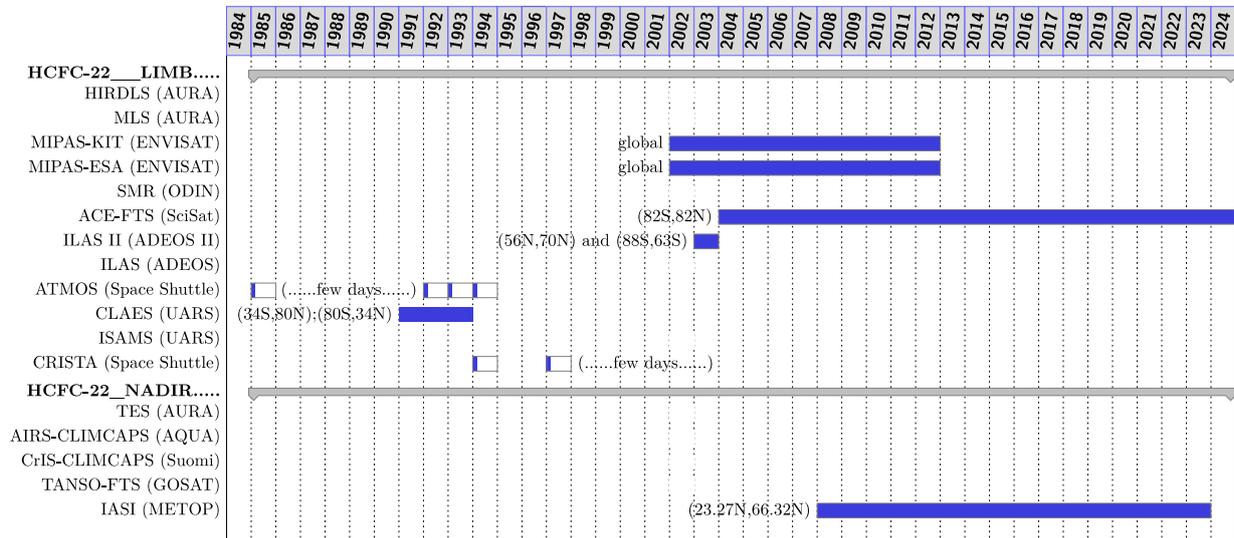
DATA AVAILABILITY

Available online. Access to Level 2 data after registration

6 HCFC-22

The summary plot of the available datasets for HCFC-22 is reported below:

| INSTRUMENT SELECTOR | | | |
|---------------------|---------------------------|----------------------|---------------------------|
| <i>LIMB</i> | --- | --- | MIPAS-KIT |
| | MIPAS-ESA | --- | ACE-FTS |
| | --- | --- | ATMOS |
| | --- | --- | --- |
| <i>NADIR</i> | --- | --- | --- |
| | --- | IASI | --- |
| | --- | --- | --- |



| | | | | | | | | | |
|---|---|-----------|------------|-----------------------|-----------|-------------|--------------------|-------------|-----------------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 85 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N₂O | CFC | | | HCFC | | HFC | | CCI4 | SF₆ |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF₄</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

6.1 MIPAS-KIT

| MIPAS-KIT HCFC-22 products | |
|---------------------------------|---|
| <i>Product type</i> | VMR profile |
| <i>Level 2 processor</i> | KIT-IAA |
| <i>Data version</i> | L1b v8 L2 2002-2004: F-22_61 (NOM) 2005-2012: F-22_161 (UTLS1), F-22_261 (NOM), F-22_561 |
| <i>Reference</i> | https://doi.org/10.5194/amt-2023-172 |
| <i>Geometry</i> | limb |
| <i>Temporal coverage</i> | 2002-2012 |
| <i>Spatial coverage</i> | global |
| <i>Spatial resolution</i> | 300-400 km below 30 km, 500 km above. |
| <i>Vertical resolution</i> | 3-4 km in troposphere, 5 km at 20 km altitude, 12 km at 38 km |
| <i>Useful vertical range</i> | 5- 50 km |
| <i>Spectroscopic database</i> | HITRAN 2016 |
| <i>Spectral range</i> | 803.5-829.5 1/cm |
| <i>Product characterization</i> | Random and systematic error, vertical resolution and DOFs |
| <i>Data Format</i> | NetCDF |
| <i>Contact</i> | gabriele.stiller@kit.edu |
| <i>Data download</i> | https://www.imk-asf.kit.edu/english/308.php |
| <i>Recommendation</i> | Paper at References will be accepted soon and there will soon be an additional source for download of the data set (w/o registration). Papers at Validation refer to preceding data version. |

THE INSTRUMENT

Short description in [INSTRUMENTS → MIPAS short description](#)

DATA OVERVIEW

CONCLUSIONS AND VALIDATION

Some insight can be gained from the ACE validation paper <https://doi.org/10.5194/egusphere-2023-2625>, where ACE to MIPAS comparisons are compiled in their Tab. 3 and Fig. 2.

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 86 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

FILTERING AND DATA QUALITY

For valid data at a given altitude the data set entries 'visibility' and 'akm_diagonal' have to be equal to 1 and greater than 0.03, respectively, at that altitude..

DATA AVAILABILITY

| | | | | | | | | | |
|---|---|-----------|------------|-------------|-----------|-------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 87 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N2O | CFC | | | HCFC | | HFC | | CCI4 | SF6 |
| | 11 | 12 | 113 | CF4 | 22 | 142b | 23 | 134a | |

6.2 MIPAS-ESA

| MIPAS-ESA HCFC-22 products | |
|---------------------------------|--|
| <i>Product type</i> | VMR profile |
| <i>Level 2 processor</i> | Optimised Retrieval Model |
| <i>Data version</i> | L2 V8.22 |
| <i>Reference</i> | https://doi.org/10.5270/EN1-c8hgqx4 ; https://earth.esa.int/eogateway/documents/20142/37627/README_V8_issue_1.0_20201221.pdf |
| <i>Geometry</i> | Limb |
| <i>Temporal coverage</i> | 2002-2012 |
| <i>Spatial coverage</i> | Global |
| <i>Spatial resolution</i> | It depends on the meas. modes, around 400-500 km for NOM |
| <i>Vertical resolution</i> | 5 km at 10 km, 7.5-10 in the range 20-30 km, about 5 at 40 km |
| <i>Useful vertical range</i> | Full reported range (6-36 km) |
| <i>Spectroscopic database</i> | Spectroscopic Database: HITRAN_mipas_pf4.45 is based on HITRAN08 (Rothman et al., 2009), but spectroscopic parameters for the molecules O2, SO2, OCS, CH3Cl, C2H2 and C2H6 are taken from HITRAN 2012 (Rothman et al., 2012). |
| <i>Spectral range</i> | Microwindows in 803.839 cm-1 |
| <i>Product characterization</i> | Random error (and CM), systematic error, AK |
| <i>Data Format</i> | NetCDF |
| <i>Contact</i> | Piera Raspollini |
| <i>Data download</i> | https://hm-atmos-ds.eo.esa.int/oads/access/collection/EnvisatMIPASL2PS |
| <i>Recommendation</i> | – |

THE INSTRUMENT

Short description in [INSTRUMENTS → MIPAS short description](#)

DATA OVERVIEW

The MIPAS level2-v8 database, along with the values of tangent pressures, temperatures, and VMR profiles of all the retrieved molecules, includes also some important products that can be used as diagnostic tools to characterise the quality of the reported results. Among them, the averaging kernels, the covariance matrices that map the random measurement noise onto the solution, and a few quality flags. All the products are stored in NetCDF files.

The L2 V8.22 dataset is described in: <https://doi.org/10.5194/amt-14-7975-2021>. The algorithm used for the reprocessing is described in: <https://doi.org/10.5194/amt-15-1871-2022>.

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|--------------------|-------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 88 | | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | | |
| | | | | | | | Version 1.0 | | | |
| | | | | | | | 15/03/2024 | | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

CONCLUSIONS AND VALIDATION

The relative random error is about 2% between 300 hPa and 50 hPa for both FR and OR measurements and 20% (40%) at 10 hPa for FR (OR) measurements.

In the FR mode period differences with MIPAS-Balloon instrument remain within $\pm 10\%$ up to 26 km turning into a significant positive bias above this altitude. In the OR observation period, deviations stay within 10% for altitudes up to 28 km while a significant negative bias is visible in the MIPAS-E data above this altitude level. Standard deviations exceed the expected precision at higher altitudes (mainly OR phase).

More details about product validation can be found in: Wetzel et al., 2022 (<https://doi.org/10.5194/amt-15-6669-2022>)

and in the Readme file:

(https://earth.esa.int/eogateway/documents/20142/37627/README_V8_issue_1.0_20201221.pdf)

FILTERING AND QUALITY FLAGGING

The quality of the retrieved profiles is determined on the basis of four criteria, two providing information on the successful convergence of the retrieval iterations, one on the capability of the retrieval to reproduce the measurements, and one on the presence of outliers in the retrieval error.

To provide an easy way to remove unreliable data, a final post-quality flag, summarising the outcome of the four quality criteria, is reported in the output files.

Take all profiles with `post_quality_flag=0`.

DATA AVAILABILITY

The data are available after registration at <https://doi.org/10.5270/EN1-c8hgqx4> (European Space Agency, 2021). The data download is free, after registration; utilisation of this data is subject to ESA's Earth Observation Terms and Conditions.

The information has been divided into two types of files: a standard one and an extended one. The standard files, one for each orbit and retrieved species, contain the information commonly required by the data users. Its filetype label is "2PS", and it is compliant with the Climate and Forecast convention (CF-1.6, Eaton et al., 2011) and with the Attribute Convention for Data Discovery (ACDD-1.3, ESIP, 2015). Extended files, identified by the filetype label "2PE", are also provided for each species and each orbit. They are "thought" for diagnostics and for advanced users, who need complete information about the retrieval process. This includes the full state vector (retrieved profiles, atmospheric continuum, and instrumental offset), along with the full CM and AKM, and additional information about the retrieval.

|

| | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 89 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N2O | CFC | | | | HCFC | | HFC | CCI4 | SF6 |
| | 11 | 12 | 113 | CF4 | 22 | 142b | 23 | 134a | |

6.3 ACE-FTS

| ACE-FTS HCFC-22 products | |
|--------------------------|--|
| Product type | VMR profile |
| Level 2 processor | |
| Data version | v5.2 |
| Reference | https://doi.org/10.1016/j.jqsrt.2023.108749 |
| Geometry | Limb |
| Temporal coverage | February 2004 - present |
| Spatial coverage | 82 N – 82 S |
| Spatial resolution | |
| Vertical resolution | ~3 km (based on FOV of instrument), 1.5-6 km sampling |
| Useful vertical range | 5 – 25 km |
| Spectroscopic database | HITRAN 2020 |
| Spectral range | Microwindows in 804-829 cm ⁻¹ |
| Product characterization | Precision estimate provided at each altitude in profile |
| Data Format | netCDF |
| Contact | Kaley Walker |
| Data download | ACE-FTS data can be accessed at the following web portal: https://databace.scisat.ca/level2/ace_v5.2/display_data.php . First time data users can register at: https://databace.scisat.ca/l2signup.php Data quality flags provided separately at: https://doi.org/10.5683/SP3/NAYNFE |
| Recommendation | • |

THE INSTRUMENT

Short description in [INSTRUMENTS → ACE-FTS short description](#)

DATA OVERVIEW

The details of the current ACE-FTS processing version are in Boone et al. (2003) <https://doi.org/10.1016/j.jqsrt.2023.108749>.

CONCLUSIONS AND VALIDATION/

v3.0 was compared to SLIMCAT output by Brown et al. (2011) <http://doi.org/10.5194/acpd-13-23491-2013>

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|--------------------|-------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 90 | | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | | |
| | | | | | | | Version 1.0 | | | |
| | | | | | | | 15/03/2024 | | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

v3.5/3.6 was validated by Chirkov et al. (2016) <https://doi.org/10.5194/acp-16-3345-2016>

v5.2 was validated (and compared with v4.1/4.2 and v3.5/3.6) by Kolonjari et al. (2023) <https://doi.org/10.5194/egusphere-2023-2625>

FILTERING AND QUALITY FLAGGING

Data quality flags are provided for ACE-FTS v5.2 at <https://doi.org/10.5683/SP3/NAYNFE> based on the methodology described in Sheese et al. (2015) <https://doi.org/10.5194/amt-8-741-2015>

It is recommended to use data where flag = 0; profiles that include a flag value of 4 or 5 can also be filtered out, except when data set contains realistic sporadic enhancements. Always look at rejected data to ensure that physically realistic data are not being filtered out. Some datasets will require further filtering.

DATA AVAILABILITY

Available online. Access to Level 2 data after registration.

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 91 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCl4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

6.4 ATMOS

For HCFC-22 profiles from ATMOS measurements see Sect. 2.9.

All retrieved species are provided in the same files.

| | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative “Plus” (CCI+) | | | | | | Page 92 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N2O | CFC | | | | HCFC | | HFC | CCI4 | SF6 |
| | 11 | 12 | 113 | CF4 | 22 | 142b | 23 | 134a | |

6.5 IASI

| IASI HCFC-22 products | |
|---------------------------------|--|
| <i>Product type</i> | Total column |
| <i>Level 2 processor</i> | |
| <i>Data version</i> | V0 |
| <i>Reference</i> | De Longueville et al., 2023 (https://doi.org/10.1016/j.jqsrt.2023.108755) |
| <i>Geometry</i> | nadir |
| <i>Temporal coverage</i> | 2008-2023 |
| <i>Spatial coverage</i> | currently only 23.27°N—66.32°N |
| <i>Spatial resolution</i> | average over all region |
| <i>Vertical resolution</i> | Total column |
| <i>Useful vertical range</i> | 0-40 km |
| <i>Spectroscopic database</i> | |
| <i>Spectral range</i> | 790-850 cm ⁻¹ |
| <i>Product characterization</i> | |
| <i>Data Format</i> | tbd |
| <i>Contact</i> | simon.whitburn@ulb.be; pierre.coheur@ulb.be |
| <i>Data download</i> | Available at ULB |
| <i>Recommendation</i> | Data to be extended globally but still on spatially averaged regions. Absolute column retrievals under investigation. |

THE INSTRUMENT

Short description in [INSTRUMENTS → IASI short description](#)

DATA OVERVIEW

Monthly concentration in the period between 2008 and 2022, retrieved by using an unconstrained generalized least squares estimation retrieval methodology, which largely allows to overcome the problem of interference.

More details in De Longueville et al., 2023 (<https://doi.org/10.1016/j.jqsrt.2023.108755>).

CONCLUSIONS AND VALIDATION

Trends are compared to the observations from AGAGE and ACE-FTS. A good match is obtained with both, with especially remarkable agreement in the linear trends for CF4, SF6 and HFC-134a, and in the non-linear trends of CFC-11 and HCFC-22.

More details in De Longueville et al., 2023 (<https://doi.org/10.1016/j.jqsrt.2023.108755>).

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 93 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCl4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

FILTERING AND DATA QUALITY

cloud flag = 0; viewing angle < 15°.

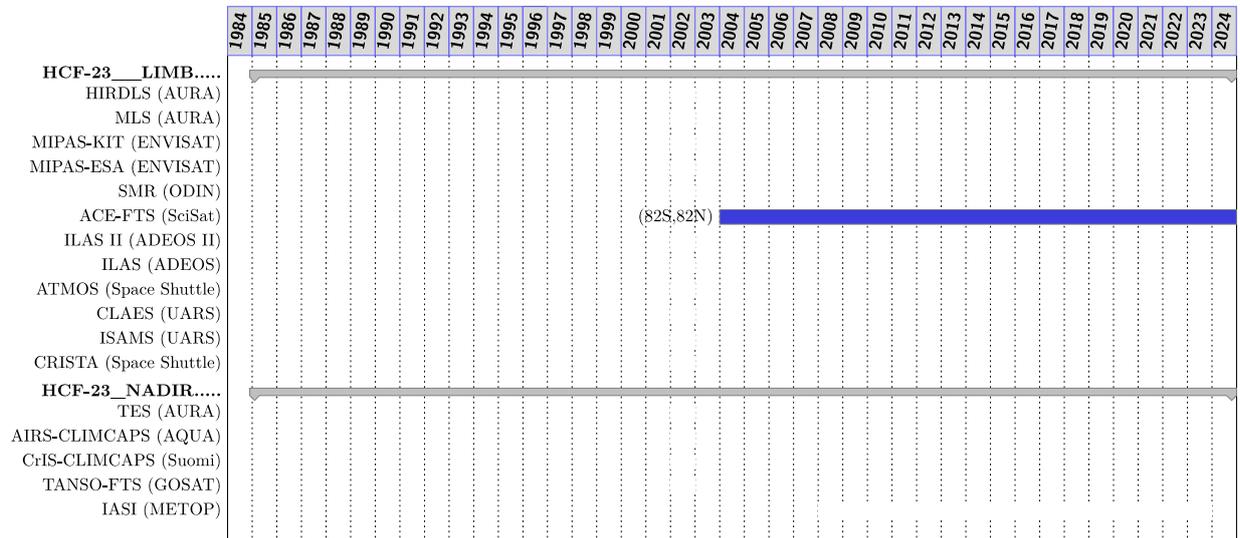
DATA AVAILABILITY

Data will be made available on request.

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|--------------------|-------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 94 | | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | | |
| | | | | | | | Version 1.0 | | | |
| | | | 15/03/2024 | | | | | | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

7 HFC-23

| INSTRUMENT SELECTOR | | | |
|---------------------|-----|-----|----------------|
| <i>LIMB</i> | --- | --- | --- |
| | --- | --- | <u>ACE-FTS</u> |
| | --- | --- | --- |
| | --- | --- | --- |
| <i>NADIR</i> | --- | --- | --- |
| | --- | --- | --- |
| | --- | --- | --- |



| | | | | | | | | | |
|---|---|-----------|------------|-----------------------|-----------|-------------|--------------------|-------------|-----------------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 95 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N₂O | CFC | | | HCFC | | HFC | | CCI4 | SF₆ |
| | 11 | 12 | 113 | CF₄ | 22 | 142b | 23 | 134a | |

7.1 ACE-FTS

| ACE-FTS HFC-23 products | |
|---------------------------------|---|
| <i>Product type</i> | VMR profile |
| <i>Level 2 processor</i> | |
| <i>Data version</i> | v5.2 |
| <i>Reference</i> | https://doi.org/10.1016/j.jqsrt.2023.108749 |
| <i>Geometry</i> | Limb |
| <i>Temporal coverage</i> | February 2004 – present |
| <i>Spatial coverage</i> | 82 N – 82 S |
| <i>Spatial resolution</i> | |
| <i>Vertical resolution</i> | ~3 km (based on FOV of instrument), 1.5-6 km sampling |
| <i>Useful vertical range</i> | 5-35 km |
| <i>Spectroscopic database</i> | HITRAN 2020 |
| <i>Spectral range</i> | Microwindows in 1140-1164 cm ⁻¹ |
| <i>Product characterization</i> | Precision estimate provided at each altitude in profile |
| <i>Data Format</i> | netCDF |
| <i>Contact</i> | Kaley Walker |
| <i>Data download</i> | ACE-FTS data can be accessed at the following web portal: https://databace.scisat.ca/level2/ace_v5.2/display_data.php . First time data users can register at https://databace.scisat.ca/l2signup.php Data quality flags provided separately at: https://doi.org/10.5683/SP3/NAYNFE |
| <i>Recommendation</i> | – |

THE INSTRUMENT

Short description in [INSTRUMENTS → ACE-FTS short description](#)

DATA OVERVIEW

The details of the current ACE-FTS processing version are in Boone et al. (2003) <https://doi.org/10.1016/j.jqsrt.2023.108749>.

CONCLUSIONS AND VALIDATION/

v5.2 was compared to AGAGE surface measurements by Boone et al. (2023) <https://doi.org/10.1016/j.jqsrt.2023.108749>

FILTERING AND QUALITY FLAGGING

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 96 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

Data quality flags are provided for ACE-FTS v5.2 at <https://doi.org/10.5683/SP3/NAYNFE> based on the methodology described in Sheese et al. (2015) <https://doi.org/10.5194/amt-8-741-2015>

It is recommended to use data where flag = 0; profiles that include a flag value of 4 or 5 can also be filtered out, except when data set contains realistic sporadic enhancements. Always look at rejected data to ensure that physically realistic data are not being filtered out. Some datasets will require further filtering.

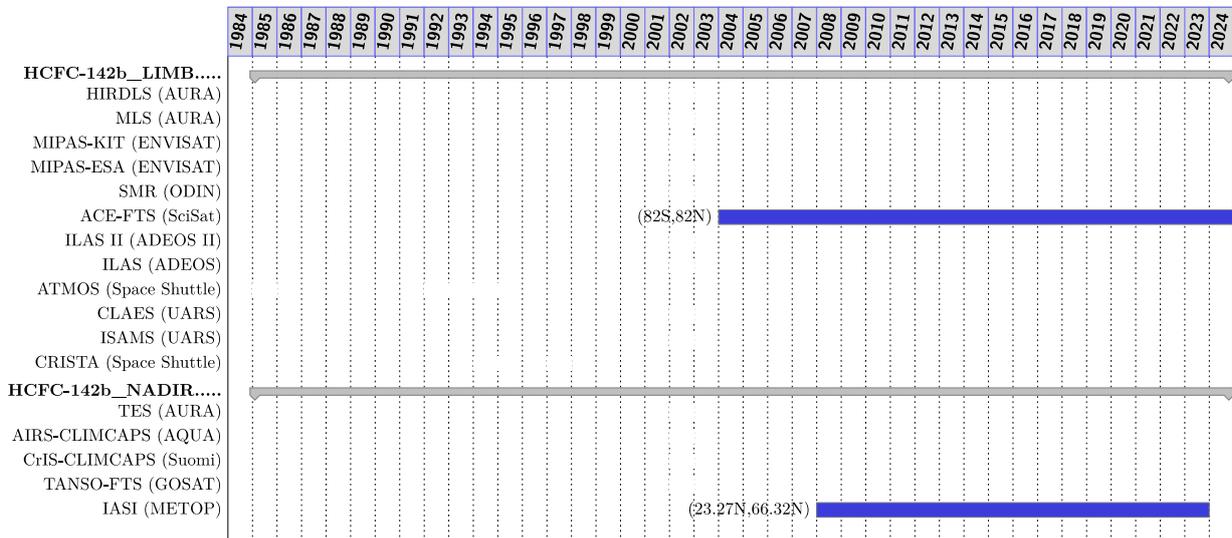
DATA AVAILABILITY

Available online. Access to Level 2 data after registration

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 97 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

8 HCFC-142b

| INSTRUMENT SELECTOR | | | |
|---------------------|-----|-------------|----------------|
| <i>LIMB</i> | --- | --- | --- |
| | --- | --- | <u>ACE-FTS</u> |
| | --- | --- | --- |
| | --- | --- | --- |
| <i>NADIR</i> | --- | --- | --- |
| | --- | <u>IASI</u> | --- |
| | --- | --- | --- |



| | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative “Plus” (CCI+) | | | | | | Page 98 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N2O | CFC | | | | HCFC | | HFC | CCI4 | SF6 |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

8.1 IASI

| IASI HCFC-142b products | |
|---------------------------------|--|
| <i>Product type</i> | Total column |
| <i>Level 2 processor</i> | |
| <i>Data version</i> | V0 |
| <i>Reference</i> | De Longueville et al., 2023 (https://doi.org/10.1016/j.jqsrt.2023.108755) |
| <i>Geometry</i> | nadir |
| <i>Temporal coverage</i> | 2008-2023 |
| <i>Spatial coverage</i> | currently only 23.27°N—66.32°N |
| <i>Spatial resolution</i> | average over all region |
| <i>Vertical resolution</i> | Total column |
| <i>Useful vertical range</i> | 0-40 km |
| <i>Spectroscopic database</i> | |
| <i>Spectral range</i> | 1190-1220 cm ⁻¹ |
| <i>Product characterization</i> | |
| <i>Data Format</i> | tbd |
| <i>Contact</i> | simon.whitburn@ulb.be; pierre.coheur@ulb.be |
| <i>Data download</i> | Available at ULB |
| <i>Recommendation</i> | Data to be extended globally but still on spatially averaged regions. Absolute column retrievals under investigation. |

THE INSTRUMENT

Short description in [INSTRUMENTS → IASI short description](#)

DATA OVERVIEW

Monthly concentration in the period between 2008 and 2022, retrieved by using an unconstrained generalized least squares estimation retrieval methodology, which largely allows to overcome the problem of interference.

More details in De Longueville et al., 2023 (<https://doi.org/10.1016/j.jqsrt.2023.108755>).

CONCLUSIONS AND VALIDATION

Trends are compared to the observations from AGAGE and ACE-FTS. A good match is obtained with both, with especially remarkable agreement in the linear trends for CF4, SF6 and HFC-134a, and in the non-linear trends of CFC-11 and HCFC-22.

Large discrepancies and unexplained variations are seen in the time series of HCFC-142b, CFC-12 and CCI4, necessitating further optimization of the retrieval technique.

More details in De Longueville et al., 2023 (<https://doi.org/10.1016/j.jqsrt.2023.108755>).

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 99 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCl4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

FILTERING AND DATA QUALITY

cloud flag = 0; viewing angle < 15°.

DATA AVAILABILITY

Data will be made available on request.

| | | | | | | | | | |
|---|---|-----------|------------|-----------------------|-----------|-------------|--------------------|-------------|-----------------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 100 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N₂O | CFC | | | HCFC | | HFC | | CCI4 | SF₆ |
| | 11 | 12 | 113 | CF₄ | 22 | 142b | 23 | 134a | |

8.2 ACE-FTS

| ACE-FTS HCFC-142b products | |
|---------------------------------|---|
| <i>Product type</i> | VMR profile |
| <i>Level 2 processor</i> | |
| <i>Data version</i> | v5.2 |
| <i>Reference</i> | https://doi.org/10.1016/j.igsrt.2023.108749 |
| <i>Geometry</i> | Limb |
| <i>Temporal coverage</i> | February 2004 - present |
| <i>Spatial coverage</i> | 82 N – 82 S |
| <i>Spatial resolution</i> | |
| <i>Vertical resolution</i> | ~3 km (based on FOV of instrument), 1.5-6 km sampling |
| <i>Useful vertical range</i> | 6-12 km |
| <i>Spectroscopic database</i> | HITRAN 2020 |
| <i>Spectral range</i> | Microwindows in 903-904 cm ⁻¹ , 1134-1135 cm ⁻¹ , and 1192-1195 cm ⁻¹ |
| <i>Product characterization</i> | Precision estimate provided at each altitude in profile |
| <i>Data Format</i> | netCDF |
| <i>Contact</i> | Kaley Walker |
| <i>Data download</i> | ACE-FTS data can be accessed at the following web portal: https://database.scisat.ca/level2/ace_v5.2/display_data.php . First time data users can register at https://database.scisat.ca/l2signup.php Data quality flags provided separately at: https://doi.org/10.5683/SP3/NAYNFE |
| <i>Recommendation</i> | – |

THE INSTRUMENT

Short description in [INSTRUMENTS → ACE-FTS short description](#)

DATA OVERVIEW

The details of the current ACE-FTS processing version are in Boone et al. (2003) <https://doi.org/10.1016/j.igsrt.2023.108749>.

CONCLUSIONS AND VALIDATION/

FILTERING AND QUALITY FLAGGING

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 101 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

Data quality flags are provided for ACE-FTS v5.2 at <https://doi.org/10.5683/SP3/NAYNFE> based on the methodology described in Sheese et al. (2015) <https://doi.org/10.5194/amt-8-741-2015>

It is recommended to use data where flag = 0; profiles that include a flag value of 4 or 5 can also be filtered out, except when data set contains realistic sporadic enhancements. Always look at rejected data to ensure that physically realistic data are not being filtered out. Some datasets will require further filtering.

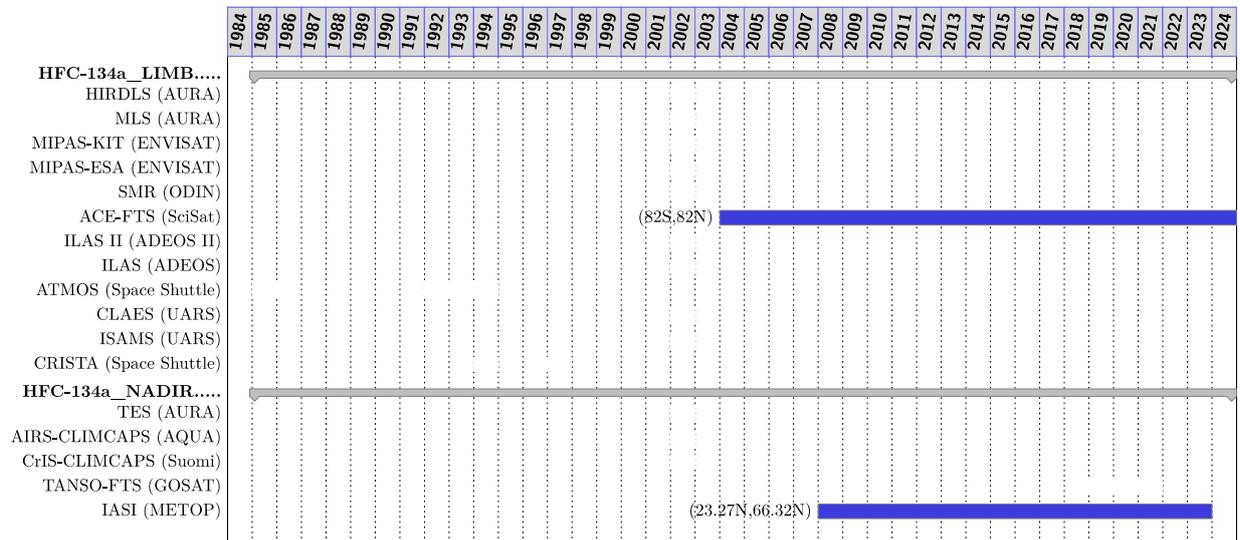
DATA AVAILABILITY

Available online. Access to Level 2 data after registration

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 102 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | 15/03/2024 | | | | | | | |
| N2O | CFC | | | | HCFC | | HFC | | CCI4 | SF6 |
| | 11 | 12 | 113 | CF4 | 22 | 142b | 23 | 134a | | |

9 HFC-134a

| INSTRUMENT SELECTOR | | | |
|---------------------|-----|-------------|----------------|
| <i>LIMB</i> | --- | --- | --- |
| | --- | --- | <u>ACE-FTS</u> |
| | --- | --- | --- |
| | --- | --- | --- |
| <i>NADIR</i> | --- | --- | --- |
| | --- | <u>IASI</u> | --- |
| | --- | --- | --- |



| | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative “Plus” (CCI+) | | | | | | Page 103 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N2O | CFC | | | | HCFC | | HFC | CCl4 | SF6 |
| | 11 | 12 | 113 | CF4 | 22 | 142b | 23 | 134a | |

9.1 IASI

| IASI HFC-134a products | |
|---------------------------------|--|
| <i>Product type</i> | Total column |
| <i>Level 2 processor</i> | |
| <i>Data version</i> | V0 |
| <i>Reference</i> | De Longueville et al., 2023 (https://doi.org/10.1016/j.jqsrt.2023.108755) |
| <i>Geometry</i> | nadir |
| <i>Temporal coverage</i> | 2008-2023 |
| <i>Spatial coverage</i> | currently only 23.27°N—66.32°N |
| <i>Spatial resolution</i> | average over all region |
| <i>Vertical resolution</i> | Total column |
| <i>Useful vertical range</i> | 0-40 km |
| <i>Spectroscopic database</i> | |
| <i>Spectral range</i> | 1150-1250 cm ⁻¹ |
| <i>Product characterization</i> | |
| <i>Data Format</i> | tbd |
| <i>Contact</i> | simon.whitburn@ulb.be; pierre.coheur@ulb.be |
| <i>Data download</i> | Available at ULB |
| <i>Recommendation</i> | Data to be extended globally but still on spatially averaged regions. Absolute column retrievals under investigation. |

THE INSTRUMENT

Short description in [INSTRUMENTS → IASI short description](#)

DATA OVERVIEW

Monthly concentration in the period between 2008 and 2022, retrieved by using an unconstrained generalized least squares estimation retrieval methodology, which largely allows to overcome the problem of interference.

More details in De Longueville et al., 2023 (<https://doi.org/10.1016/j.jqsrt.2023.108755>).

CONCLUSIONS AND VALIDATION

Trends are compared to the observations from AGAGE and ACE-FTS. A good match is obtained with both, with especially remarkable agreement in the linear trends for CF4, SF6 and HFC-134a, and in the non-linear trends of CFC-11 and HCFC-22.

More details in De Longueville et al., 2023 (<https://doi.org/10.1016/j.jqsrt.2023.108755>).

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 104 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

FILTERING AND DATA QUALITY

cloud flag = 0; viewing angle < 15°.

DATA AVAILABILITY

Data will be made available on request.

| | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative “Plus” (CCI+) | | | | | | Page 105 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N2O | CFC | | | | HCFC | | HFC | CCI4 | SF6 |
| | 11 | 12 | 113 | CF4 | 22 | 142b | 23 | 134a | |

9.2 ACE-FTS

| ACE-FTS HFC-134a products | |
|---------------------------------|---|
| <i>Product type</i> | VMR profile |
| <i>Level 2 processor</i> | |
| <i>Data version</i> | v5.2 |
| <i>Reference</i> | https://doi.org/10.1016/j.igsrt.2023.108749 |
| <i>Geometry</i> | Limb |
| <i>Temporal coverage</i> | February 2004 - present |
| <i>Spatial coverage</i> | 82 N – 82 S |
| <i>Spatial resolution</i> | |
| <i>Vertical resolution</i> | ~3 km (based on FOV of instrument), 1.5-6 km sampling |
| <i>Useful vertical range</i> | 5 – 25 km |
| <i>Spectral range</i> | Microwindow in 1104-1105 cm ⁻¹ |
| <i>Product characterization</i> | Precision estimate provided at each altitude in profile |
| <i>Data Format</i> | netCDF |
| <i>Contact</i> | Kaley Walker |
| <i>Data download</i> | ACE-FTS data can be accessed at the following web portal: https://databace.scisat.ca/level2/ace_v5.2/display_data.php . First time data users can register at https://databace.scisat.ca/l2signup.php Data quality flags provided separately at: https://doi.org/10.5683/SP3/NAYNFE |
| <i>Recommendation</i> | – |

THE INSTRUMENT

Short description in [INSTRUMENTS → ACE-FTS short description](#)

DATA OVERVIEW

The details of the current ACE-FTS processing version are in Boone et al. (2003) <https://doi.org/10.1016/j.igsrt.2023.108749>.

CONCLUSIONS AND VALIDATION

v4.0 was compared to SLIMCAT output by Harrison et al. (2021) <https://doi.org/10.1029/2020JD033208>

FILTERING AND QUALITY FLAGGING

Data quality flags are provided for ACE-FTS v5.2 at <https://doi.org/10.5683/SP3/NAYNFE> based on the methodology described in Sheese et al. (2015) <https://doi.org/10.5194/amt-8-741-2015>

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 106 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

It is recommended to use data where flag = 0; profiles that include a flag value of 4 or 5 can also be filtered out, except when data set contains realistic sporadic enhancements. Always look at rejected data to ensure that physically realistic data are not being filtered out. Some datasets will require further filtering.

DATA AVAILABILITY

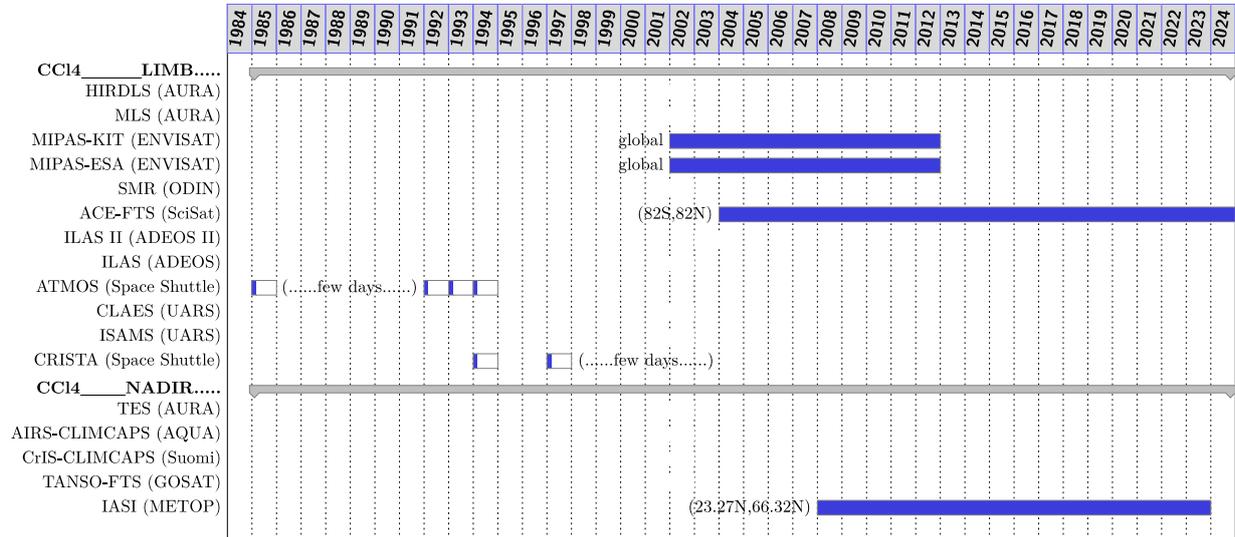
Available online. Access to Level 2 data after registration

| | | | | | | | | | |
|---|--|-----------|------------|--------------------|-----------|-------------|-----------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) OLLGHGs INVENTORY (URD) | | | Page 107 | | | | | |
| | | | | [D1.1] LOLIPOP_URD | | | | | |
| | | | | Version 1.0 | | | | | |
| | | | | 15/03/2024 | | | | | |
| <u>N2O</u> | <u>CFC</u> | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

10 CCI4

In the table below the available datasets are indicated by the blue rectangles indicating the corresponding temporal coverage.

| INSTRUMENT SELECTOR | | | |
|---------------------|------------------|-------------|------------------|
| <i>LIMB</i> | -- | -- | <u>MIPAS-KIT</u> |
| | <u>MIPAS-ESA</u> | -- | <u>ACE-FTS</u> |
| | -- | -- | <u>ATMOS</u> |
| | -- | -- | <u>CRISTA</u> |
| <i>NADIR</i> | -- | -- | -- |
| | -- | <u>IASI</u> | -- |
| | -- | -- | -- |



| | | | | | | | | | |
|---|---|-----------|------------|-------------|-----------|-------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 108 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

10.1 MIPAS-KIT

| MIPAS-KIT CCI4 products | |
|---------------------------------|---|
| <i>Product type</i> | VMR profile |
| <i>Level 2 processor</i> | KIT-IAA |
| <i>Data version</i> | L1b v8 L2 2002-2004: CCL4_61 (NOM) L2 2005-2012: CCL4_161 (UTLS1), CCL4_261 (NOM) |
| <i>Reference</i> | https://doi.org/10.5194/amt-10-2727-2017 |
| <i>Geometry</i> | limb |
| <i>Temporal coverage</i> | 2002-2012 |
| <i>Spatial coverage</i> | global |
| <i>Spatial resolution</i> | 300 km at tropopause increasing to 500 km at 30 km |
| <i>Vertical resolution</i> | 3 km at tropopause increasing to 6 km at 30 km |
| <i>Useful vertical range</i> | 5- 30 km |
| <i>Spectroscopic database</i> | HITRAN 2016 |
| <i>Spectral range</i> | 773-800 1/cm |
| <i>Product characterization</i> | Random and systematic error, vertical resolution and DOFs |
| <i>Data Format</i> | NetCDF |
| <i>Contact</i> | gabriele.stiller@kit.edu |
| <i>Data download</i> | https://www.imk-asf.kit.edu/english/308.php |
| <i>Recommendation</i> | the reference for the preceding data version is given; also for validation. |

THE INSTRUMENT

Short description in [INSTRUMENTS → MIPAS short description](#)

DATA OVERVIEW

CONCLUSIONS AND VALIDATION

Previous version validation: <https://doi.org/10.5194/amt-10-2727-2017>

Comparisons with ACE-FTS and MIPAS-B2 show very good agreement and historical measurements of MIPAS-B2 and ATMOS are coherent with MIPAS Envisat CCI4 results using the new spectroscopic data. MIPAS profiles retrieved using the new spectroscopic data set agree well with cryosampler and deviations between the measurements can be explained reasonably.

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 109 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

FILTERING AND DATA FLAGGING

For valid data at a given altitude the data set entries 'visibility' and 'akm_diagonal' have to be equal to 1 and greater than 0.03, respectively, at that altitude.

DATA AVAILABILITY

MIPAS data can be accessed at the following website:

<https://www.imk-asf.kit.edu/english/308.php>

| | | | | | | | | | |
|---|---|-----------|------------|-------------|-----------|-------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 110 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N2O | CFC | | | HCFC | | HFC | | CCI4 | SF6 |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

10.2 MIPAS-ESA

| MIPAS-ESA CCI4 products | |
|---------------------------------|--|
| <i>Product type</i> | VMR profile |
| <i>Level 2 processor</i> | Optimised Retrieval Model |
| <i>Data version</i> | L2 V8.22 |
| <i>Reference</i> | https://doi.org/10.5270/EN1-c8hgqx4 ; https://earth.esa.int/eogateway/documents/20142/37627/README_V8_issue_1.0_20201221.pdf |
| <i>Geometry</i> | Limb |
| <i>Temporal coverage</i> | 2002-2012 |
| <i>Spatial coverage</i> | Global |
| <i>Spatial resolution</i> | It depends on the meas. modes, around 400-500 km for NOM |
| <i>Vertical resolution</i> | 10 km at 6 km and 5-7.5 km between 10 and 30 km |
| <i>Useful vertical range</i> | Full range reported in the output files (6-26 Km in nominal mode) |
| <i>Spectroscopic database</i> | Spectroscopic Database: HITRAN_mipas_pf4.45 is based on HITRAN08 (Rothman et al., 2009), but spectroscopic parameters for the molecules O2, SO2, OCS, CH3Cl, C2H2 and C2H6 are taken from HITRAN 2012 (Rothman et al., 2012). |
| <i>Spectral range</i> | Microwindows in 771.8-803.275 cm-1 |
| <i>Product characterization</i> | Random error (and CM), systematic error, AK |
| <i>Data Format</i> | NetCDF |
| <i>Contact</i> | Piera Raspollini |
| <i>Data download</i> | https://hm-atmos-ds.eo.esa.int/oads/access/collection/EnvisatMIPASL2PS |
| <i>Recommendation</i> | – |

THE INSTRUMENT

Short description in [INSTRUMENTS → MIPAS short description](#)

DATA OVERVIEW

The MIPAS level2-v8 database, along with the values of tangent pressures, temperatures, and VMR profiles of all the retrieved molecules, includes also some important products that can be used as diagnostic tools to characterise the quality of the reported results. Among them, the averaging kernels, the covariance matrices that map the random measurement noise onto the solution, and a few quality flags. All the products are stored in NetCDF files.

The L2 V8.22 dataset is described in: <https://doi.org/10.5194/amt-14-7975-2021>. The algorithm used for the reprocessing is described in: <https://doi.org/10.5194/amt-15-1871-2022>.

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|--------------------|-------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 111 | | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | | |
| | | | | | | | Version 1.0 | | | |
| | | | | | | | 15/03/2024 | | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

CONCLUSIONS AND VALIDATION

The random error is 5-6% between 6 and 100 hPa for both FR and OR measurements, then it rapidly increases as a consequence of the rapid decrease of the CCI4 profile with altitude.

The comparison of both MIPAS instruments reveals a significant negative bias in the MIPAS-E CCI4 data (full period) above 22 km (see Figure 4-86), which is at the brink of the combined systematic error limits. A significant positive bias is visible below 21 km during the OR phase. However, differences stay within $\pm 20\%$ up to about 22 km in both observation periods

More details about product validation can be found in: Wetzel et al., 2022 (<https://doi.org/10.5194/amt-15-6669-2022>)

and in the Readme file:

(https://earth.esa.int/eogateway/documents/20142/37627/README_V8_issue_1.0_20201221.pdf)

FILTERING AND QUALITY FLAGGING

The quality of the retrieved profiles is determined on the basis of four criteria, two providing information on the successful convergence of the retrieval iterations, one on the capability of the retrieval to reproduce the measurements, and one on the presence of outliers in the retrieval error.

To provide an easy way to remove unreliable data, a final post-quality flag, summarising the outcome of the four quality criteria, is reported in the output files.

Take all profiles with `post_quality_flag=0`.

DATA AVAILABILITY

The data are available after registration at <https://doi.org/10.5270/EN1-c8hgqx4> (European Space Agency, 2021). The data download is free, after registration; utilisation of this data is subject to ESA's Earth Observation Terms and Conditions.

The information has been divided into two types of files: a standard one and an extended one. The standard files, one for each orbit and retrieved species, contain the information commonly required by the data users. Its filetype label is "2PS", and it is compliant with the Climate and Forecast convention (CF-1.6, Eaton et al., 2011) and with the Attribute Convention for Data Discovery (ACDD-1.3, ESIP, 2015). Extended files, identified by the filetype label "2PE", are also provided for each species and each orbit. They are "thought" for diagnostics and for advanced users, who need complete information about the retrieval process. This includes the full state vector (retrieved profiles, atmospheric continuum, and instrumental offset), along with the full CM and AKM, and additional information about the retrieval

| | | | | | | | | | |
|---|---|-----------|------------|-----------------------|-------------|-------------|--------------------|-------------|-----------------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 112 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N₂O | CFC | | | | HCFC | | HFC | CCI4 | SF₆ |
| | 11 | 12 | 113 | CF₄ | 22 | 142b | 23 | 134a | |

10.3 ACE-FTS

| ACE-FTS CCI4 products | |
|---------------------------------|---|
| <i>Product type</i> | VMR profile |
| <i>Level 2 processor</i> | |
| <i>Data version</i> | v5.2 |
| <i>Reference</i> | https://doi.org/10.1016/j.igsrt.2023.108749 |
| <i>Geometry</i> | Limb |
| <i>Temporal coverage</i> | February 2004 – present |
| <i>Spatial coverage</i> | 82 N – 82 S |
| <i>Spatial resolution</i> | |
| <i>Vertical resolution</i> | ~3 km (based on FOV of instrument), 1.5-6 km sampling |
| <i>Useful vertical range</i> | Varies with latitude, at Poles: 6 – 25 km; Equator: 8 – 30 km |
| <i>Spectroscopic database</i> | HITRAN 2020 |
| <i>Spectral range</i> | Microwindows in 772-812 cm ⁻¹ |
| <i>Product characterization</i> | Precision estimate provided at each altitude in profile |
| <i>Data Format</i> | netCDF |
| <i>Contact</i> | Kaley Walker |
| <i>Data download</i> | ACE-FTS data can be accessed at the following web portal: https://databace.scisat.ca/level2/ace_v5.2/display_data.php . First time data users can register at https://databace.scisat.ca/l2signup.php Data quality flags provided separately at: https://doi.org/10.5683/SP3/NAYNFE |
| <i>Recommendation</i> | – |

THE INSTRUMENT

Short description in [INSTRUMENTS → ACE-FTS short description](#)

DATA OVERVIEW

The details of the current ACE-FTS processing version are in Boone et al. (2003) <https://doi.org/10.1016/j.igsrt.2023.108749>.

CONCLUSIONS AND VALIDATION

v3.0 was compared to SLIMCAT output by Brown et al. (2011) <http://doi.org/10.5194/acpd-13-23491-2013>

v3.5 was validated by Eckert et al. (2017) <https://doi.org/10.5194/amt-10-2727-2017>

FILTERING AND QUALITY FLAGGING

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 113 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

Data quality flags are provided for ACE-FTS v5.2 at <https://doi.org/10.5683/SP3/NAYNFE> based on the methodology described in Sheese et al. (2015) <https://doi.org/10.5194/amt-8-741-2015>

It is recommended to use data where flag = 0; profiles that include a flag value of 4 or 5 can also be filtered out, except when data set contains realistic sporadic enhancements. Always look at rejected data to ensure that physically realistic data are not being filtered out. Some datasets will require further filtering.

DATA AVAILABILITY

Available online. Access to Level 2 data after registration

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 114 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

10.4 ATMOS

For CCI4 profiles from ATMOS measurements see Sect. 2.9.

All retrieved species are provided in the same files.

10.5 CRISTA/Space Shuttle

For CCI4 profiles from CRISTA measurements see Section 2.12.

All retrieved species are provided in the same files.

| | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative “Plus” (CCI+) | | | | | | Page 115 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N2O | CFC | | | | HCFC | | HFC | CCI4 | SF6 |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

10.6 IASI

| IASI CCI4 products | |
|---------------------------------|--|
| <i>Product type</i> | Total column |
| <i>Level 2 processor</i> | |
| <i>Data version</i> | V0 |
| <i>Reference</i> | De Longueville et al., 2023 (https://doi.org/10.1016/j.jqsrt.2023.108755) |
| <i>Geometry</i> | nadir |
| <i>Temporal coverage</i> | 2008-2023 |
| <i>Spatial coverage</i> | currently only 23.27°N—66.32°N |
| <i>Spatial resolution</i> | average over all region |
| <i>Vertical resolution</i> | Total column |
| <i>Useful vertical range</i> | 0-40 km |
| <i>Spectroscopic database</i> | |
| <i>Spectral range</i> | 760-820 cm ⁻¹ |
| <i>Product characterization</i> | |
| <i>Data Format</i> | tbd |
| <i>Contact</i> | simon.whitburn@ulb.be; pierre.coheur@ulb.be |
| <i>Data download</i> | Available at ULB |
| <i>Recommendation</i> | Data to be extended globally but still on spatially averaged regions. Absolute column retrievals under investigation. |

THE INSTRUMENT

Short description in [INSTRUMENTS → IASI short description](#)

DATA OVERVIEW

Monthly concentration in the period between 2008 and 2022, retrieved by using an unconstrained generalized least squares estimation retrieval methodology, which largely allows to overcome the problem of interference.

More details in De Longueville et al., 2023 (<https://doi.org/10.1016/j.jqsrt.2023.108755>).

CONCLUSIONS AND VALIDATION

Trends are compared to the observations from AGAGE and ACE-FTS. A good match is obtained with both, with especially remarkable agreement in the linear trends for CF4, SF6 and HFC-134a, and in the non-linear trends of CFC-11 and HCFC-22.

Large discrepancies and unexplained variations are seen in the time series of HCFC-142b, CFC-12 and CCI4, necessitating further optimization of the retrieval technique.

More details in De Longueville et al., 2023 (<https://doi.org/10.1016/j.jqsrt.2023.108755>).

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 116 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

FILTERING AND DATA QUALITY

cloud flag = 0; viewing angle < 15°.

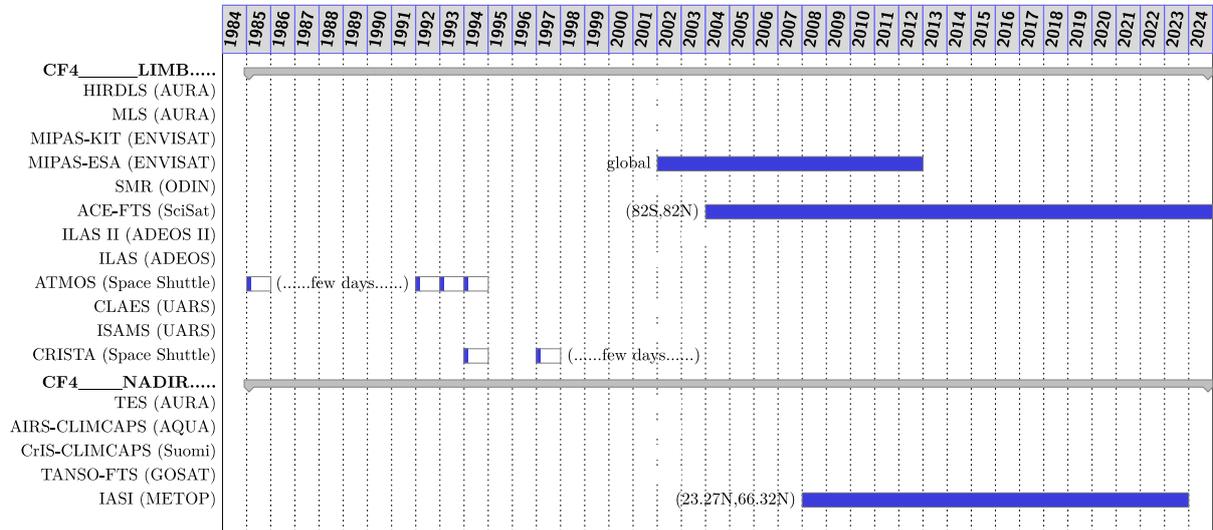
DATA AVAILABILITY

Data will be made available on request.

| | | | | | | | | | | |
|---|--|-----------|--------------------|------------|-------------|-------------|------------|-------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) OLLGHGs INVENTORY (URD) | | Page 117 | | | | | | | |
| | | | [D1.1] LOLIPOP_URD | | | | | | | |
| | | | Version 1.0 | | | | | | | |
| | | | 15/03/2024 | | | | | | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

11 CF4

| INSTRUMENT SELECTOR | | | |
|---------------------|------------------|-------------|----------------|
| <i>LIMB</i> | --- | --- | --- |
| | <u>MIPAS-ESA</u> | --- | <u>ACE-FTS</u> |
| | --- | --- | <u>ATMOS</u> |
| | --- | --- | <u>CRISTA</u> |
| <i>NADIR</i> | --- | --- | --- |
| | --- | <u>IASI</u> | --- |
| | --- | --- | --- |



| | | | | | | | | | |
|---|---|--------------------|---------------------|--------------------------------|--------------------|----------------------|--------------------|------------------------|-----------------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 118 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N₂O | CFC | | | HCFC | | HFC | | CCl₄ | SF₆ |
| | 11 | 12 | 113 | CF₄ | 22 | 142b | 23 | 134a | |

11.1 MIPAS-ESA

| MIPAS-ESA CF4 products | |
|---------------------------------|--|
| <i>Product type</i> | VMR profile |
| <i>Level 2 processor</i> | Optimised Retrieval Model |
| <i>Data version</i> | L2 V8.22 |
| <i>Reference</i> | https://doi.org/10.5270/EN1-c8hgqx4 ; https://earth.esa.int/eogateway/documents/20142/37627/REA_DME_V8_issue_1.0_20201221.pdf |
| <i>Geometry</i> | Limb |
| <i>Temporal coverage</i> | 2002-2012 |
| <i>Spatial coverage</i> | Global |
| <i>Spatial resolution</i> | It depends on the meas. modes, around 400-500 km for NOM |
| <i>Vertical resolution</i> | It is 3-5 (3-7.5) km in the range 10-40 km for FR (OR) measurements and 7 (10) km at 50 km |
| <i>Useful vertical range</i> | Full range reported in the output files |
| <i>Spectroscopic database</i> | Spectroscopic Database: HITRAN_mipas_pf4.45 is based on HITRAN08 (Rothman et al., 2009), but spectroscopic parameters for the molecules O ₂ , SO ₂ , OCS, CH ₃ Cl, C ₂ H ₂ and C ₂ H ₆ are taken from HITRAN 2012 (Rothman et al., 2012). |
| <i>Spectral range</i> | Microwindows in 1256-1288 cm ⁻¹ |
| <i>Product characterization</i> | Random error (and CM), systematic error, AK |
| <i>Data Format</i> | NetCDF |
| <i>Contact</i> | Piera Raspollini |
| <i>Data download</i> | https://hm-atmos-ds.eo.esa.int/oads/access/collection/EnvisatMIPASL2PS |
| <i>Recommendation</i> | – |

THE INSTRUMENT

Short description in [INSTRUMENTS → MIPAS short description](#)

DATA OVERVIEW

The MIPAS level2-v8 database, along with the values of tangent pressures, temperatures, and VMR profiles of all the retrieved molecules, includes also some important products that can be used as diagnostic tools to characterise the quality of the reported results. Among them, the averaging kernels, the covariance matrices that map the random measurement noise onto the solution, and a few quality flags. All the products are stored in NetCDF files.

The L2 V8.22 dataset is described in: <https://doi.org/10.5194/amt-14-7975-2021>. The algorithm used for the reprocessing is described in: <https://doi.org/10.5194/amt-15-1871-2022>.

| | | | | | | | | | |
|---|---|-----------|------------|-----------------------|-----------|-------------|--------------------|-------------|-----------------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 119 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N₂O | CFC | | | HCFC | | HFC | | CCI4 | SF₆ |
| | 11 | 12 | 113 | CF₄ | 22 | 142b | 23 | 134a | |

CONCLUSIONS AND VALIDATION

The relative random error varies between 8 and 15% from 150 hPa to 2 hPa, outside this range it increases going to the highest and the lowest altitudes

Comparison results of both MIPAS instruments concerning the species CF₄ are shown in Figure 4-98. A general agreement between both instruments can be stated between 11 and 37 km (within $\pm 10\%$ in full observation period). In the FR phase, a significant positive bias above 10 km is visible. In contrast, no clear bias is obvious in the OR period where differences stay within $\pm 10\%$ at all altitudes. However, standard deviations exceed the expected precision in the OR phase

More details about product validation can be found in: Wetzel et al., 2022 (<https://doi.org/10.5194/amt-15-6669-2022>)

and in the Readme file:

(https://earth.esa.int/eogateway/documents/20142/37627/README_V8_issue_1.0_20201221.pdf)

FILTERING AND QUALITY FLAGGING

The quality of the retrieved profiles is determined on the basis of four criteria, two providing information on the successful convergence of the retrieval iterations, one on the capability of the retrieval to reproduce the measurements, and one on the presence of outliers in the retrieval error.

To provide an easy way to remove unreliable data, a final post-quality flag, summarising the outcome of the four quality criteria, is reported in the output files.

Take all profiles with `post_quality_flag=0`.

DATA AVAILABILITY

The data are available after registration at <https://doi.org/10.5270/EN1-c8hgqx4> (European Space Agency, 2021). The data download is free, after registration; utilisation of this data is subject to ESA's Earth Observation Terms and Conditions.

The information has been divided into two types of files: a standard one and an extended one. The standard files, one for each orbit and retrieved species, contain the information commonly required by the data users. Its filetype label is "2PS", and it is compliant with the Climate and Forecast convention (CF-1.6, Eaton et al., 2011) and with the Attribute Convention for Data Discovery (ACDD-1.3, ESIP, 2015). Extended files, identified by the filetype label "2PE", are also provided for each species and each orbit. They are "thought" for diagnostics and for advanced users, who need complete information about the retrieval process. This includes the full state vector (retrieved profiles, atmospheric continuum, and instrumental offset), along with the full CM and AKM, and additional information about the retrieval.

| | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 120 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N2O | CFC | | | | HCFC | | HFC | CCI4 | SF6 |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

11.2 ACE-FTS

| ACE-FTS CF4 products | |
|---------------------------------|---|
| <i>Product type</i> | VMR profile |
| <i>Level 2 processor</i> | |
| <i>Data version</i> | v5.2 |
| <i>Reference</i> | https://doi.org/10.1016/j.jqsrt.2023.108749 |
| <i>Geometry</i> | Limb |
| <i>Temporal coverage</i> | February 2004 – present |
| <i>Spatial coverage</i> | 82 N – 82 S |
| <i>Spatial resolution</i> | |
| <i>Vertical resolution</i> | ~3 km (based on FOV of instrument), 1.5-6 km sampling |
| <i>Useful vertical range</i> | 15-55 km |
| <i>Spectroscopic database</i> | HITRAN 2020 |
| <i>Spectral range</i> | Microwindows at 1282-1283 cm ⁻¹ |
| <i>Product characterization</i> | Precision estimate provided at each altitude in profile |
| <i>Data Format</i> | netCDF |
| <i>Contact</i> | Kaley Walker |
| <i>Data download</i> | ACE-FTS data can be accessed at the following web portal: https://databace.scisat.ca/level2/ace_v5.2/display_data.php . First time data users can register at https://databace.scisat.ca/l2signup.php Data quality flags provided separately at: https://doi.org/10.5683/SP3/NAYNFE |
| <i>Recommendation</i> | – |

THE INSTRUMENT

Short description in [INSTRUMENTS → ACE-FTS short description](#)

DATA OVERVIEW

The details of the current ACE-FTS processing version are in Boone et al. (2003) <https://doi.org/10.1016/j.jqsrt.2023.108749>.

CONCLUSIONS AND VALIDATION/

v2.2+updates was validated by Velazco et al. (2011) <https://doi.org/10.1029/2010JD014928> (using non-coincident MkIV balloon profiles)

FILTERING AND QUALITY FLAGGING

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 121 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

Data quality flags are provided for ACE-FTS v5.2 at <https://doi.org/10.5683/SP3/NAYNFE> based on the methodology described in Sheese et al. (2015) <https://doi.org/10.5194/amt-8-741-2015>

It is recommended to use data where flag = 0; profiles that include a flag value of 4 or 5 can also be filtered out, except when data set contains realistic sporadic enhancements. Always look at rejected data to ensure that physically realistic data are not being filtered out. Some datasets will require further filtering.

DATA AVAILABILITY

Available online. Access to Level 2 data after registration

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 122 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

11.3 ATMOS

For CF4 profiles from ATMOS measurements see Sect. 2.9.

All retrieved species are provided in the same files.

11.4 CRISTA/Space Shuttle

For CCI4 profiles from CRISTA measurements see Section 2.12.

| | | | | | | | | | |
|---|---|-----------|------------|-------------|-----------|-------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative “Plus” (CCI+) | | | | | | Page 123 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N2O | CFC | | | HCFC | | HFC | | CCI4 | SF6 |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

11.5 IASI

| IASI CF4 products | |
|---------------------------------|--|
| <i>Product type</i> | Total column |
| <i>Level 2 processor</i> | |
| <i>Data version</i> | V0 |
| <i>Reference</i> | De Longueville et al., 2023 (https://doi.org/10.1016/j.jqsrt.2023.108755) |
| <i>Geometry</i> | nadir |
| <i>Temporal coverage</i> | 2008-2023 |
| <i>Spatial coverage</i> | currently only 23.27°N—66.32°N |
| <i>Spatial resolution</i> | average over all region |
| <i>Vertical resolution</i> | Total column |
| <i>Useful vertical range</i> | 0-40 km |
| <i>Spectroscopic database</i> | |
| <i>Spectral range</i> | 1250-1290 cm ⁻¹ |
| <i>Product characterization</i> | |
| <i>Data Format</i> | tbd |
| <i>Contact</i> | simon.whitburn@ulb.be; pierre.coheur@ulb.be |
| <i>Data download</i> | Available at ULB |
| <i>Recommendation</i> | Data to be extended globally but still on spatially averaged regions. Absolute column retrievals under investigation. |

THE INSTRUMENT

Short description in [INSTRUMENTS → IASI short description](#)

DATA OVERVIEW

Monthly concentration in the period between 2008 and 2022, retrieved by using an unconstrained generalized least squares estimation retrieval methodology, which largely allows to overcome the problem of interference.

More details in De Longueville et al., 2023 (<https://doi.org/10.1016/j.jqsrt.2023.108755>).

CONCLUSIONS AND VALIDATION

Trends are compared to the observations from AGAGE and ACE-FTS. A good match is obtained with both, with especially remarkable agreement in the linear trends for CF4, SF6 and HFC-134a, and in the non-linear trends of CFC-11 and HCFC-22.

More details in De Longueville et al., 2023 (<https://doi.org/10.1016/j.jqsrt.2023.108755>).

FILTERING AND DATA QUALITY

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 124 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

cloud flag = 0; viewing angle < 15°.

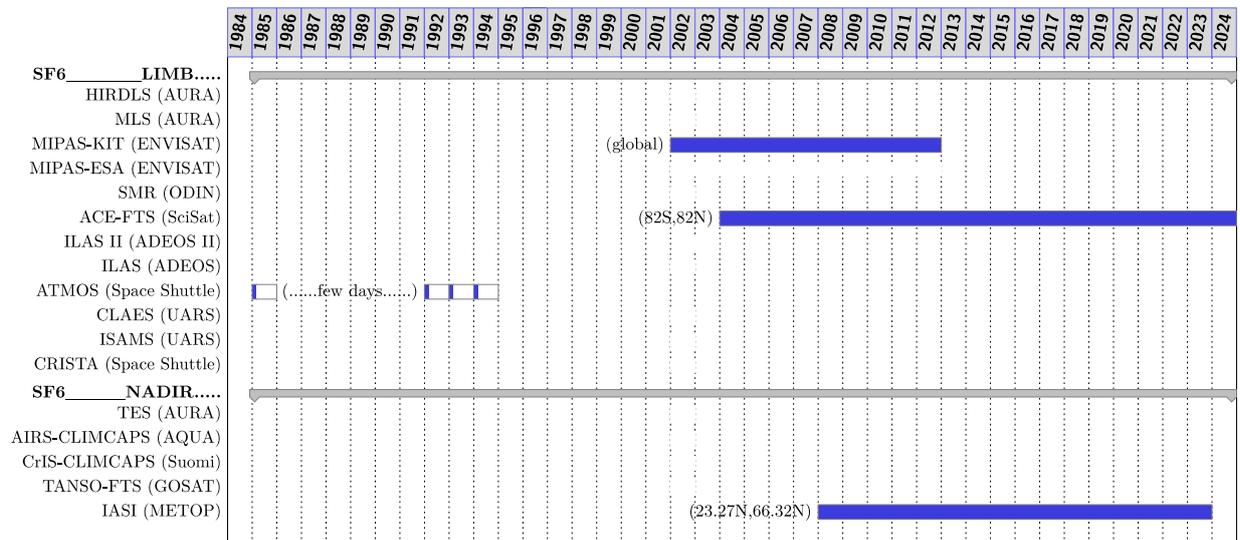
DATA AVAILABILITY

Data will be made available on request.

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 125 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | | |
| N2O | CFC | | | | HCFC | | HFC | | CCI4 | SF6 |
| | 11 | 12 | 113 | CF4 | 22 | 142b | 23 | 134a | | |

12 SF6

| INSTRUMENT SELECTOR | | | |
|---------------------|-----|-------------|------------------|
| <i>LIMB</i> | --- | --- | <u>MIPAS-KIT</u> |
| | --- | --- | <u>ACE-FTS</u> |
| | --- | --- | <u>ATMOS</u> |
| | --- | --- | --- |
| <i>NADIR</i> | --- | --- | --- |
| | --- | <u>IASI</u> | --- |
| | --- | --- | --- |



| | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 126 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N2O | CFC | | | | HCFC | | HFC | CCI4 | SF6 |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

12.1 MIPAS-KIT

| MIPAS-KIT SF6 products | |
|---------------------------------|--|
| <i>Product type</i> | VMR profile |
| <i>Level 2 processor</i> | KIT-IAA |
| <i>Data version</i> | ?? |
| <i>Reference</i> | Reference for preceding data version: https://doi.org/10.5194/acp-8-677-2008 |
| <i>Geometry</i> | limb |
| <i>Temporal coverage</i> | 2002-2012 |
| <i>Spatial coverage</i> | global |
| <i>Spatial resolution</i> | Increasing from 300 km at tropopause to 500 km at 40 km |
| <i>Vertical resolution</i> | 3-4 km at 10km, 5 km at 20 km, 7 km at 30 km, 11 km at 40 km |
| <i>Useful vertical range</i> | 5- 40 km |
| <i>Spectral range</i> | 941-952 cm ⁻¹ |
| <i>Product characterization</i> | Random and systematic error, vertical resolution and DOFs |
| <i>Data Format</i> | NetCDF |
| <i>Contact</i> | gabriele.stiller@kit.edu |
| <i>Data download</i> | https://www.imk-asf.kit.edu/english/308.php |
| <i>Recommendation</i> | the reference for the preceding data version is given; also for validation |

THE INSTRUMENT

Short description in [INSTRUMENTS → MIPAS short description](#)

DATA OVERVIEW

CONCLUSIONS AND VALIDATION/

FILTERING

<https://doi.org/10.5194/essd-8-61-2016>

DATA AVAILABILITY

<https://doi.org/10.5194/essd-8-61-2016>

| | | | | | | | | | |
|---|---|-----------|------------|-----------------------|-------------|-------------|--------------------|-------------|-----------------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 127 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N₂O | CFC | | | | HCFC | | HFC | CCI4 | SF₆ |
| | 11 | 12 | 113 | CF₄ | 22 | 142b | 23 | 134a | |

12.2 ACE-FTS

| ACE-FTS SF6 products | |
|---------------------------------|--|
| <i>Product type</i> | VMR profile |
| <i>Level 2 processor</i> | |
| <i>Data version</i> | v5.2 |
| <i>Reference</i> | https://doi.org/10.1016/j.jqsrt.2023.108749 |
| <i>Geometry</i> | Limb |
| <i>Temporal coverage</i> | February 2004 – present |
| <i>Spatial coverage</i> | 82 N – 82 S |
| <i>Spatial resolution</i> | |
| <i>Vertical resolution</i> | ~3 km (based on FOV of instrument), 1.5-6 km sampling |
| <i>Useful vertical range</i> | Varies with latitude, at Poles: 8 – 32 km; Equator: 12 – 32 km |
| <i>Spectroscopic database</i> | HITRAN 2020 |
| <i>Spectral range</i> | Microwindow at 948 cm ⁻¹ |
| <i>Product characterization</i> | Precision estimate provided at each altitude in profile |
| <i>Data Format</i> | netCDF |
| <i>Contact</i> | Kaley Walker |
| <i>Data download</i> | ACE-FTS data can be accessed at the following web portal: https://databace.scisat.ca/level2/ace_v5.2/display_data.php . First time data users can register at https://databace.scisat.ca/l2signup.php . Data quality flags provided separately at: https://doi.org/10.5683/SP3/NAYNFE |
| <i>Recommendation</i> | – |

THE INSTRUMENT

Short description in [INSTRUMENTS → ACE-FTS short description](#)

DATA OVERVIEW

The details of the current ACE-FTS processing version are in Boone et al. (2003) <https://doi.org/10.1016/j.jqsrt.2023.108749>.

CONCLUSIONS AND VALIDATION/

v3.5/3.6 and v4.1/4.2 have been compared by Saunders (PhD thesis, Feb. 2024)

Work on v5.2 is on-going.

FILTERING AND QUALITY FLAGGING

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | | Page 128 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

Data quality flags are provided for ACE-FTS v5.2 at <https://doi.org/10.5683/SP3/NAYNFE> based on the methodology described in Sheese et al. (2015) <https://doi.org/10.5194/amt-8-741-2015>

It is recommended to use data where flag = 0; profiles that include a flag value of 4 or 5 can also be filtered out, except when data set contains realistic sporadic enhancements. Always look at rejected data to ensure that physically realistic data are not being filtered out. Some datasets will require further filtering.

DATA AVAILABILITY

Available online. Access to Level 2 data after registration

| | | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|--------------------|-------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 129 | | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | | |
| | | | | | | | Version 1.0 | | | |
| | | | | | | | 15/03/2024 | | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

12.3 ATMOS

For SF6 profiles from ATMOS measurements see Sect. 2.9.

All retrieved species are provided in the same files.

| | | | | | | | | | |
|---|---|-----------|------------|------------|-------------|-------------|--------------------|-------------|------------|
|  | ESA Climate Change Initiative "Plus" (CCI+) | | | | | | Page 130 | | |
| | OLLGHGs INVENTORY (URD) | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | Version 1.0 | | |
| | | | | | | | 15/03/2024 | | |
| N2O | CFC | | | | HCFC | | HFC | CCI4 | SF6 |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

12.4 IASI

| IASI SF6 products | |
|---------------------------------|--|
| <i>Product type</i> | Total column |
| <i>Level 2 processor</i> | |
| <i>Data version</i> | V0 |
| <i>Reference</i> | De Longueville et al., 2023 (https://doi.org/10.1016/j.jqsrt.2023.108755) |
| <i>Geometry</i> | nadir |
| <i>Temporal coverage</i> | 2008-2023 |
| <i>Spatial coverage</i> | currently only 23.27°N—66.32°N |
| <i>Spatial resolution</i> | average over all region |
| <i>Vertical resolution</i> | Total column |
| <i>Useful vertical range</i> | 0-40 km |
| <i>Spectroscopic database</i> | |
| <i>Spectral range</i> | 935-955 cm ⁻¹ |
| <i>Product characterization</i> | |
| <i>Data Format</i> | tbd |
| <i>Contact</i> | simon.whitburn@ulb.be; pierre.coheur@ulb.be |
| <i>Data download</i> | Available at ULB |
| <i>Recommendation</i> | Data to be extended globally but still on spatially averaged regions. Absolute column retrievals under investigation. |

THE INSTRUMENT

Short description in [INSTRUMENTS → IASI short description](#)

DATA OVERVIEW

Monthly concentration in the period between 2008 and 2022, retrieved by using an unconstrained generalized least squares estimation retrieval methodology, which largely allows to overcome the problem of interference.

More details in De Longueville et al., 2023 (<https://doi.org/10.1016/j.jqsrt.2023.108755>).

CONCLUSIONS AND VALIDATION

Trends are compared to the observations from AGAGE and ACE-FTS. A good match is obtained with both, with especially remarkable agreement in the linear trends for CF4, SF6 and HFC-134a, and in the non-linear trends of CFC-11 and HCFC-22.

More details in De Longueville et al., 2023 (<https://doi.org/10.1016/j.jqsrt.2023.108755>).

FILTERING AND DATA QUALITY

| | | | | | | | | | | |
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| | OLLGHGs INVENTORY (URD) | | | | | | | [D1.1] LOLIPOP_URD | | |
| | | | | | | | | Version 1.0 | | |
| | | | | | | | | 15/03/2024 | | |
| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCl4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

cloud flag = 0; viewing angle < 15°.

DATA AVAILABILITY

Data will be made available on request.

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| | | | | | | | 15/03/2024 | | |
| N2O | CFC | | | | HCFC | | HFC | CCI4 | SF6 |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

13 L1 radiance available for reprocessing

Measurements for which no OLLGHG L2 data were found, but L1 radiance could be available for reprocessing

13.1 IMG

Interferometric Monitor for Greenhouse Gases (IMG, 1996–1997).

Description of the instrument and of the L2 products: doi:[10.1109/36.763262](https://doi.org/10.1109/36.763262), but L2 data (processed with HITRAN 1992 spectroscopic database) have not been found online.

L1 data could be available at LISA-CNRS. These could be reprocessed if needed.

13.2 IRIS

The first high resolution terrestrial infrared spectra were measured from space by the Infrared Interferometer Spectrometer (IRIS, 1969–1971) on-board the meteorological platform Nimbus 3 and 4, revealing carbon dioxide, water vapor, methane, nitrous oxide and ozone absorption bands [Hanel et al., 1972]. Although the potential of nadir looking hyper-spectral infrared sounders was realized early on, the technology at the time could not provide the spatial resolution and revisit time required for the operational retrieval of weather variables.

<https://www.ecmwf.int/sites/default/files/elibrary/2016/16338-meteorological-satellite-data-rescue-assessing-radiances-nimbus-iv-iris-1970-1971-and-nimbus.pdf>

L1 data at: [IRIS/Nimbus-4 Level 1 Radiance Data V001 \(IRISN4RAD 001\)](#)

IRISN4RAD

Longname: IRIS/Nimbus-4 Level 1 Radiance Data V001

Version:001

Format: binary

Spatial Coverage: -180.0,-90.0,180.0,90.0

Temporal Coverage: 1970-04-09 to 1971-01-31

Data Resolution Spatial: 94 km x 94 km

Temporal: 1 day

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| | | | | | | | 15/03/2024 | | |
| N₂O | CFC | | | | HCFC | | HFC | CCl₄ | SF₆ |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF₄</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

14 INSTRUMENTS

14.1 HIRDLS short description

The High Resolution Dynamics Limb Sounder (HIRDLS) instrument was launched on the Aura satellite in August 2004. HIRDLS is an infrared limb-scanning radiometer designed to sound the upper troposphere, stratosphere, and mesosphere to determine temperature; the mixing ratios of various gases, Geopotential Height (GPH), and aerosols; and the locations of polar stratospheric clouds and cloud tops.

Overall science goals of HIRDLS are to observe the global distributions of temperature and several trace species in the stratosphere and upper troposphere at high vertical and horizontal resolution.

HIRDLS performs limb scans in the vertical, measuring infrared emissions in 21 channels ranging from 6.12 to 17.76 μm

More details on HIRDLS instrument can be found at: <https://aura.gsfc.nasa.gov/hirdls.html>

14.2 EOS MLS short description

EOS MLS is a successor to the MLS experiment [Waters et al., 1999; Barath et al., 1993] that formed part of the Upper Atmosphere Research Satellite (UARS), launched in September 1991 [Reber, 1993; Reber et al., 1993]. The instrument is designed to study aspects of the chemistry and dynamics of the atmosphere, from the upper troposphere to the mesopause. The microwave heterodyne technique is employed to observe thermal microwave emission from the Earth's limb in several spectral bands, designed to characterize emission from O₂ (used to obtain temperature and pressure information), O₃, H₂O, ClO, HCl, HNO₃, N₂O, CO, OH, SO₂, BrO, HOCl, HO₂, HCN and CH₃CN.

(text extracted from https://mls.jpl.nasa.gov/data/eos_algorithm_atbd.pdf)

14.3 MIPAS short description

The Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) was a payload of the Envisat research satellite of the European Space Agency (ESA). Envisat performed 14.4 polar sun-synchronous orbits per day, enabling measurements with global coverage. MIPAS relied on the measurement technique of mid-infrared Fourier transform spectrometry operating in limb-viewing geometry (Fischer et al., 2008). The spectral coverage was 4.1 to 14.6 μm (685–2410 cm^{-1}). In the first phase of the mission, from June 2002 to March 2004, MIPAS measured at a full spectral resolution (FR) of 0.025 cm^{-1} (unapodized). After a technical defect of the interferometer slide, spectra were recorded with a reduced spectral resolution of 0.0625 cm^{-1} (unapodized) but finer vertical resolution from January 2005 to April 2012.

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| <u>N₂O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCI4</u> | <u>SF₆</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF₄</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | | |

14.4 SMR short description

The SMR instrument (onboard ODIN satellite) employs four tunable single-sideband Schottky-diode heterodyne receivers in the ~486–581 GHz spectral range as well as one mm-wave receiver at ~119 GHz. Observations of thermal emission of trace gases originating from the Earth's limb are performed in a time-sharing mode with astronomical observations using a 1.1-m telescope. Spectra are recorded by means of two high-resolution auto-correlators, one acousto-optical spectrometer, and a three-channel filter bank for the 119-GHz radiometer. The Odin satellite was launched on 20 February 2001 into a circular quasi-polar low Earth orbit at ~600 km altitude.

Various target bands are dedicated to profile measurements of trace constituents relevant to stratospheric and mesospheric chemistry and dynamics such as O₃, ClO, N₂O, HNO₃, H₂O, CO, and NO, as well as isotopes of H₂O and O₃. Stratospheric mode measurements are performed typically twice per week using the two auto-correlator spectrometers centered at 501.8 and 544.6 GHz.

(text extracted from: J. Urban et Al. <https://doi.org/10.1029/2004JD005741>)

14.5 ACE-FTS short description

The Atmospheric Chemistry Experiment Fourier Transform Spectrometer (ACE-FTS) is the primary instrument on board the SCISAT satellite (Bernath et al., 2005 <https://doi.org/10.1029/2005GL022386>). The instrument operates in the mid-infrared region (750-4400 cm⁻¹) with a spectral resolution of 0.02 cm⁻¹. It uses solar occultation to obtain profiles of atmospheric composition twice each orbit, resulting in up to 30 profile measurements per day. Launched in August 2003, it began nominal measurements in late February 2004 and continues to operate to this day. SCISAT is in a highly inclined circular orbit thus ACE-FTS focuses on high-latitude measurements with global coverage provided every three months.

14.6 ILAS II short description

The Improved Limb Atmospheric Spectrometer (ILAS)-II is a satellite-borne sensor that measures ozone and its related chemical species in the high-latitude stratosphere on the basis of the solar occultation technique (Nakajima et al., 2006). ILAS-II is the successor to ILAS, which was continuously operated from November 1996 through June 1997 (Sasano, 2002, and references therein). ILAS-II was launched onboard the Advanced Earth Observing Satellite (ADEOS)-II on December 14, 2002 from Tanegashima Space Center facility (30°N, 131°E) of the Japan Aerospace Exploration Agency (JAXA). During these periods, ILAS-II obtained 5890 observations, ranging in latitude from 54°N to 71°N and from 64°S to 88°S, depending on the season. There are approximately 14 measurements a day for each of the hemispheres, at sunrise seen from the satellite in the Northern Hemisphere (NH) and at sunset seen from the satellite in the Southern Hemisphere (SH). Local times at the Earth's surface are always p.m. in the NH, but in the SH they are a.m. between the end of March and the end of September, and p.m. at other times (Nakajima et al., 2006). Ranges of the measurement altitude (in the data files) of nitrous oxide (N₂O) are from 50 km to ~12 km. The lower limit varies from event to event, with a limiting factor of the sun tracking system (Tanaka et al., 2007).

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| N2O | CFC | | | | HCFC | | HFC | | CCI4 | SF6 |
| | 11 | 12 | 113 | CF4 | 22 | 142b | 23 | 134a | | |

ILAS-II mainly consists of the infrared channel (6.2–11.8 μm with 44 spectral elements) and the visible channel (753–784 nm with 1024 spectral elements), which were also used on ILAS. Two infrared channels (the mid-infrared channel (3.0–5.7 μm with 22 spectral elements) and the other infrared channel (12.78–12.85 μm with 22 spectral elements) are added in ILAS-II (Nakajima et al., 2006). An improved version of the sun-edge sensor (SES) from that used in ILAS was also installed (Tanaka et al., 2007). The data sampling rate of 10 Hz (i.e., data points with ancillary measurements every 0.1 sec) is used for all channels and the SES. The instantaneous field of view at the tangent height (TH) has a 1 km height in the vertical direction and a 13 km width in the horizontal direction for the infrared channel. Applying a data smoothing digital filter for 21 consecutive data points, the vertical resolutions are estimated to be 1.3 km at a TH of 15 km and 2.9 km at a TH of 50 km, depending on atmospheric refraction (Yokota et al., 2006). Measurements were performed with two different mode data acquisitions as DC and AC (Nakajima et al., 2006). Since there is no difference between the data products as measured exclusively with the two modes, it is seamless to handle both of the branch numbers in data versions, e.g., 3.00 (DC mode) and 3.01 (AC mode)..

14.7 ILAS short description

The Improved Limb Atmospheric Spectrometer (ILAS) is a satellite-borne sensor that measures ozone and its related chemical species in the high-latitude stratosphere on the basis of the solar occultation technique. ILAS was launched on 17 August 1996 on board the Advanced Earth Observing Satellite (ADEOS). There are approximately 14 measurements a day for each of the hemispheres, at sunrise seen from the satellite in the Northern Hemisphere and at sunset seen from the satellite in the Southern Hemisphere.

14.8 TES short description

TES was an instrument aboard NASA's Aura satellite and was launched from California on July 15, 2004. Data collection for TES is complete.

Nadir and limb observations were added to separate L2 files, and a single ancillary file was composed of data that are common to both nadir and limb files. A Nadir sequence within the TES Global Survey was a fixed number of observations within an orbit for a Global Survey. Prior to April 24, 2005, it consisted of two low resolution scans over the same ground locations. After April 24, 2005, Global Survey data consisted of three low resolution scans. The Nadir standard product consists of four files, where each file is composed of the Global Survey Nadir observations from one of four focal planes for a single orbit, i.e. 72 orbit sequences. The Global Survey Nadir observations only used a single set of filter mix.

14.9 AIRS (CLIMCAPS observing system) short description

AIRS is a cross-track scanning instrument. A scan mirror rotates around an axis along the line of flight and directs infrared energy from the Earth into the instrument. As the spacecraft moves along, this mirror sweeps the ground creating a scan 'swath' that extends roughly 800 km on either side of the ground track. Between Earth scans, the scan mirror also allows the instrument to view various calibration sources. The scan mirror provides $\pm 49.5^\circ$ (from nadir) Earth coverage along with views to space and to on-board spectral and radiometric calibration

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| <u>N2O</u> | <u>CFC</u> | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCl4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

sources every scan cycle. The AIRS scan mirror rotates 360° every 8/3 of a second (2.667 seconds), so that AIRS does three scans for every 8- second AMSU-A scan.

The CLIMCAPS (Community Long-term Infrared Microwave Coupled Product System) algorithm is used to analyze data from the AIRS (Atmospheric Infrared Sounder) and AMSU (Advanced Microwave Sounding Unit)

More details in:

"<https://docserver.gesdisc.eosdis.nasa.gov/public/project/Sounder/CLIMCAPS.V2.README.pdf>"

(text extracted from: Nadia Smith et Al. <https://doi.org/10.5194/amt-13-4437-2020>)

14.10 TANSO-FTS short description

The TANSO-FTS-2 (Thermal And Near infrared Sensor for carbon Observation - Fourier Transform Spectrometer-2) instrument is an high-resolution 5-bands (NIR and TIR) spectrometer which allows the observation of reflective and emissive radiative energy from Earth's surface and the atmosphere for the measurement of atmospheric chemistry and greenhouse gases.

TANSO-FTS-2 is operating from GOSAT-2 (Greenhouse gases Observing Satellite-2), a JAXA satellite dedicated to the observation of greenhouse gases. The satellite expands upon the capabilities of its predecessor and carries enhanced versions of the two mission instruments aboard the GOSAT.

14.11 IASI short description

IASI (Infrared Atmospheric Sounding Interferometer) is a spaceborne instrument on board the platforms MetOp-A and MetOp-B. It measures in the infrared part of the electromagnetic spectrum between 645 and 2760 cm⁻¹ (15.5 and 3.63 μm). After apodisation (L1c spectra) the spectral resolution is 0.5 cm⁻¹ (full width at half maximum, FWHM). It provides global Earth coverage twice a day, with an overpass time at ~9.30 (day) and ~21.30 (night) local solar time and a 12 km footprint at nadir.

The main objective of the mission is to provide high resolution atmospheric emission spectra to derive temperature and humidity profiles with high spectral and vertical resolution and accuracy. Additionally, it is used for the determination of trace gases, as well as land and sea surface temperature, emissivity and cloud properties. The Trace Gases (TRG) product contains the total column amounts of atmospheric trace gases: N2O, CO, CH4, CO2, retrieved from IASI sounder measurements.

14.12 ATMOS short description

ATMOS is an infrared spectrometer (a Fourier transform interferometer) designed to derive vertical concentrations of various trace gases in the atmosphere, particularly the ozone depleting chlorine and fluorine based molecules. The ATMOS instrument has flown four times on the Space Shuttle from 1985 to 1993.

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| <u>N₂O</u> | <u>CFC</u> | | | <u>HCFC</u> | | <u>HFC</u> | | <u>CCl₄</u> | <u>SF₆</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF₄</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

Spacelab 3: The STS-51B/Spacelab 3 mission was launched on April 30, 1985 (30 April - 1 May 1985). There were 4 measurements taken at orbital sunrise between 77 south and 79 south latitude, and 11 measurements between 25 north and 35 north latitude.

The STS-45/ATLAS 1 mission was launched on March 24, 1992. During 8 days of operation, the ATMOS instrument made a total of 98 observations. The 53 measurements taken at orbital sunrise covered the mid-latitude and equatorial regions of the earth from 30 degrees south to 30 degrees north. The 41 sunset observations were made at 25 south to 55 south. ATMOS was only able to monitor the atmosphere down to a height of about 20 km, due to a recent eruption of Mount Pinatubo, which clouded the region below that with dust and aerosols.

The STS-56/ATLAS 2 mission was launched on April 8, 1993. During 9 days of operation, the ATMOS instrument made a total of 104 observations, 65 at sunrise in the north polar region around 65 degrees north, and 39 at sunset between 10 and 50 degrees south.

The STS-66/ATLAS 3 mission was launched on November 3, 1994. During nearly 11 days of operation, the ATMOS instrument made a total of 228 observations, 105 over the northern hemisphere at sunset, and 94 over the south polar region (Antarctica) at sunrise.

14.13 CRISTA short description

CRISTA (*C*Ryogenic *I*nfrared Spectrometers and Telescopes for the Atmosphere) is a cryogenically cooled infrared limb sounding instrument optimized to measure trace gases in the middle atmosphere on a dense horizontal grid. This is achieved by using three independent telescopes each followed by grating spectrometers for the midinfrared spectral regime. The three telescopes (called L, C, and R for *l*eft, *c*enter, and *r*ight, respectively) simultaneously sense three atmospheric volumes separated by 18° in azimuth. The three tracks of the CRISTA instrument are separated by about 650 km at the tangent point in the stratosphere, in the case when the main axis of the instrument (which is the center telescope viewing direction) lies in the orbital plane. The distance between two air volumes along the orbital flight direction is a function of the time needed to perform one altitude scan and is between 200 and 600 km except for some special observation modes. (text extracted by <https://doi.org/10.1029/2001JD000667>)

14.14 CLAES short description

The Cryogenic Limb Array Etalon Spectrometer (CLAES) is one of 10 instruments aboard the Upper Atmosphere Research Satellite (UARS). The CLAES instrument measured the altitude profiles of temperature and a series of minor and trace gases important in stratospheric ozone chemistry. Measured gas species include ozone, water vapor, methane, members of the nitrogen and chlorine families, and two chlorofluorocarbons. CLAES also obtained aerosol extinction coefficients at several infrared wavelengths. These data capture the vertical distributions of important ozone-layer gases in the stratosphere and their variation with time of day, season, latitude, and longitude.

The CLAES instrument collects infrared radiation through its 6-inch aperture Mersene telescope. Spectroscopy is performed by tilt scanning one of the four solid etalons between one or more of the nine blocking filters.

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| <u>N2O</u> | <u>CFC</u> | | | | <u>HCFC</u> | | <u>HFC</u> | <u>CCl4</u> | <u>SF6</u> |
| | <u>11</u> | <u>12</u> | <u>113</u> | <u>CF4</u> | <u>22</u> | <u>142b</u> | <u>23</u> | <u>134a</u> | |

14.15 ISAMS short description

The Improved Stratospheric and Mesospheric Sounder (ISAMS) is one of 10 instruments aboard the Upper Atmosphere Research Satellite (UARS). ISAMS is a limb sounder, which, at the satellite altitude of 585km, places the tangent point at 23 degrees from the orbital track. When the satellite flies in the +X direction (defined as forwards), viewing to the (usual) anti-sun side (+Y) gives coverage from 80N to 34S. Conversely, when the satellite yaws to fly in the -X direction (backwards), the coverage viewing to +Y is from 34N to 80S. ISAMS also has the ability, when the sun-satellite geometry is favorable, to view to the -Y side for parts of orbits, increasing the potential coverage to 80N-80S for either satellite flight direction.

The ISAMS instrument is an infrared spectroradiometer which collects infrared radiation at wavelengths from 4.6 to 16.3 microns. ISAMS is able to scan on either side of the UARS satellite, though the instrument views primarily to the cold (anti-sun) side of the craft. Pressure modulators allow ISAMS to measure selected atmospheric gases.

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