

# FRM4GHG 2.0

## Fiducial Reference Measurements for Greenhouse Gases



### Technical Note on ECMWF data stream for PROFFAST

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## 1 DOCUMENT CHANGE RECORD

Issue	Date	Item	Comment
V0.0	2023-03-01	-	Initial version
V0.1	2023-03-30		Submitted version

## 2 ACCESS LIST

This document is a deliverable “D3.1.1: TN: ECMWF data-stream – created for the project FRM4GHG 2.0 and will be submitted to ESA. The document can be downloaded from the project webpage <http://frm4ghg.aeronomie.be>.

## 3 PURPOSE

The document describes the progress in establishing a data stream between ECMWF and consortium for getting the pressure and temperature profiles and Copernicus Atmosphere Monitoring Service (CAMS) data as a priori profiles in an operation way for use in PROFFAST.

## 4 DOCUMENT STRUCTURE

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## 5 PRESSURE, TEMPERATURE AND TRACE GAS PROFILES

The Copernicus Atmospheric Monitoring Service (CAMS) focuses on atmospheric composition and produces daily analysis, forecasts as well as reanalysis products. The creation of the reanalysis data uses the ingestion of improved versions of the original observations thereby benefiting the quality of the product. The global reanalysis data set of atmospheric composition (AC) consists of 3-dimensional time-consistent AC fields, including aerosols, chemical species and greenhouse gases (GG), which is provided through the separate EGG4. The current reanalysis product of the greenhouse gases (EGG4) covers a period of 18 years (2003 - 2020). Later this year it is expected that the data of more recent years be released as well. The entire re-analysis data will provided to the users from the Copernicus Atmosphere Datastore (ADS)

<https://atmosphere.copernicus.eu/data>. The meteorological model is based on integrated forecast system (IFS) version CY42R1; the model resolution is T255L60 (a reduced Gaussian grid with 60 vertical levels). The data are available at sub daily (6 hour) and monthly frequency (synoptic monthly means and monthly means of daily means).

Another candidate CAMS data set is the operational GG high resolution model data. The analysis run is updated daily with a latency of about 5 days and is available on an octahedral grid with 137 vertical layers (O400L137). The operational analysis data is more recent but contains the results of different experiments and is not one consistent data set for the complete time series of available data. For more information on the IFS model and data assimilation system please see:

<https://confluence.ecmwf.int/display/CKB/CAMS%3A+Reanalysis+data+documentation>. For more details on the orthogonal reduced Gaussian grid you can see this article:

<https://confluence.ecmwf.int/display/FCST/Introducing+the+octahedral+reduced+Gaussian+grid>

At BIRA-IASB, we are downloading for both CAMS analysis experiments overpass data for a list of ground-based validation stations that belong to the Total Carbon Column Observing Network (TCCON) and Infrared Working Group of the Network for the Detection of Atmospheric Composition Change (NDACC-IRWG). A grid box is defined around each site and the data are stored. These data are currently downloaded on a weekly basis but the frequency can be increased upon request. The overpass files for all sites are stored in a single netCDF file.

For the current task in this project, we have extracted the profile information of the pressure, temperature, water vapour, carbon dioxide, methane, density and gravity and stored them in a special format (.map files) similar to what the TCCON community is using. An example file is provided in as annex to this document. This format is also used as the input by the PROFFAST processing chain within the COCCON community. As a next step, we will share this data with project partners in Karlsruhe Institute of Technology (KIT), who will then work towards the ingestion of the data to the PROFFAST processing chain.

## 6 APPLICABLE DOCUMENTS

Statement of Work: Fiducial Reference Measurements for Ground-Based IR Greenhouse Gas Observations (FRM4GHG 2.0)

Prepared by: EOP-GMQ, Reference: ESA-EOPG-EOPGMQ-SOW-21

## 7 REFERENCE DOCUMENTS

CAMS global greenhouse gas reanalysis (EGG4):

<https://ads.atmosphere.copernicus.eu/cdsapp#!/dataset/cams-global-ghg-reanalysis-egg4?tab=overview>

Copernicus Climate Change Service, Climate Data Store, (2023): ERA5 monthly averaged data on pressure levels from 1940 to present. Copernicus Climate Change Service (C3S) Climate Data Store (CDS), DOI: [10.24381/cds.6860a573](https://doi.org/10.24381/cds.6860a573) (Accessed on 30-03-2023)

## 8 ANNEX: AN EXAMPLE FILE

```
# 12 8
```

```
# xx_yy_zz_2023010100Z.map
```

```
# GINPUT          Version 1.0.6   JLL, SR, MK
```

```
# Please see https://tcon-wiki.caltech.edu for a complete description of this file and its usage.
```

# NOTE: The gas concentrations (including H2O) are WET MOLE FRACTIONS. If you require dry mole fractions,

# you must calculate  $[H_2O]_{dry} = (1/[H_2O]_{wet} - 1)^{-1}$  and then  $[gas]_{dry} = [gas]_{wet} * (1 + [H_2O]_{dry})$ .

# Avogadro (molecules/mole): 6.022141e+23

# Mass\_Dry\_Air (kg/mole): 0.028964

# Mass\_H2O (kg/mole): 0.01801534

# Latitude (degrees): 49.100

# Height,Temp,Pressure,Density,h2o,co2,ch4,gravity

# km,K,hPa,molecules/cm\*\*3,ppv,ppm,ppb,m/s2

2.307E-01 2.868E+02 9.915E+02 2.440E+19 4.367E-03 4.320E+02 1.997E+03 9.809E+00  
2.517E-01 2.871E+02 9.890E+02 2.485E+19 4.355E-03 4.312E+02 1.994E+03 9.809E+00  
2.746E-01 2.873E+02 9.863E+02 2.476E+19 4.343E-03 4.305E+02 1.992E+03 9.809E+00  
2.997E-01 2.874E+02 9.834E+02 2.468E+19 4.331E-03 4.299E+02 1.991E+03 9.809E+00  
3.272E-01 2.874E+02 9.802E+02 2.460E+19 4.319E-03 4.294E+02 1.990E+03 9.809E+00  
3.572E-01 2.873E+02 9.767E+02 2.452E+19 4.306E-03 4.290E+02 1.989E+03 9.809E+00  
3.900E-01 2.873E+02 9.729E+02 2.443E+19 4.291E-03 4.286E+02 1.988E+03 9.809E+00  
4.259E-01 2.872E+02 9.688E+02 2.433E+19 4.272E-03 4.283E+02 1.987E+03 9.809E+00  
4.650E-01 2.870E+02 9.643E+02 2.423E+19 4.250E-03 4.279E+02 1.986E+03 9.808E+00  
5.077E-01 2.869E+02 9.594E+02 2.413E+19 4.223E-03 4.276E+02 1.985E+03 9.808E+00  
5.543E-01 2.867E+02 9.541E+02 2.401E+19 4.189E-03 4.272E+02 1.985E+03 9.808E+00  
6.051E-01 2.865E+02 9.484E+02 2.388E+19 4.141E-03 4.269E+02 1.984E+03 9.808E+00  
6.605E-01 2.863E+02 9.421E+02 2.374E+19 4.076E-03 4.265E+02 1.983E+03 9.808E+00  
7.207E-01 2.862E+02 9.354E+02 2.359E+19 3.977E-03 4.261E+02 1.981E+03 9.808E+00  
7.862E-01 2.862E+02 9.281E+02 2.341E+19 3.843E-03 4.256E+02 1.979E+03 9.807E+00  
8.574E-01 2.863E+02 9.203E+02 2.321E+19 3.605E-03 4.250E+02 1.973E+03 9.807E+00  
9.348E-01 2.864E+02 9.118E+02 2.300E+19 3.275E-03 4.244E+02 1.966E+03 9.807E+00  
1.019E+00 2.863E+02 9.028E+02 2.279E+19 2.946E-03 4.238E+02 1.958E+03 9.807E+00  
1.110E+00 2.859E+02 8.930E+02 2.258E+19 2.685E-03 4.234E+02 1.951E+03 9.806E+00  
1.208E+00 2.852E+02 8.826E+02 2.237E+19 2.499E-03 4.231E+02 1.945E+03 9.806E+00  
1.314E+00 2.843E+02 8.715E+02 2.217E+19 2.357E-03 4.229E+02 1.941E+03 9.806E+00  
1.428E+00 2.833E+02 8.596E+02 2.195E+19 2.250E-03 4.228E+02 1.937E+03 9.805E+00  
1.550E+00 2.821E+02 8.470E+02 2.172E+19 2.167E-03 4.228E+02 1.935E+03 9.805E+00  
1.681E+00 2.809E+02 8.337E+02 2.146E+19 2.122E-03 4.228E+02 1.935E+03 9.805E+00  
1.821E+00 2.799E+02 8.196E+02 2.118E+19 1.988E-03 4.227E+02 1.932E+03 9.804E+00  
1.971E+00 2.792E+02 8.047E+02 2.086E+19 1.668E-03 4.225E+02 1.928E+03 9.804E+00  
2.131E+00 2.784E+02 7.891E+02 2.053E+19 1.399E-03 4.224E+02 1.925E+03 9.803E+00  
2.301E+00 2.773E+02 7.728E+02 2.018E+19 1.375E-03 4.225E+02 1.924E+03 9.803E+00  
2.482E+00 2.760E+02 7.558E+02 1.983E+19 1.527E-03 4.225E+02 1.923E+03 9.802E+00  
2.673E+00 2.747E+02 7.381E+02 1.946E+19 1.879E-03 4.225E+02 1.923E+03 9.802E+00  
2.874E+00 2.732E+02 7.198E+02 1.908E+19 2.277E-03 4.223E+02 1.922E+03 9.801E+00  
3.085E+00 2.718E+02 7.010E+02 1.868E+19 2.439E-03 4.221E+02 1.921E+03 9.800E+00  
3.307E+00 2.705E+02 6.817E+02 1.825E+19 2.160E-03 4.221E+02 1.922E+03 9.800E+00  
3.539E+00 2.695E+02 6.620E+02 1.779E+19 1.500E-03 4.222E+02 1.925E+03 9.799E+00  
3.782E+00 2.685E+02 6.420E+02 1.733E+19 9.075E-04 4.223E+02 1.929E+03 9.798E+00  
4.033E+00 2.671E+02 6.217E+02 1.687E+19 6.478E-04 4.223E+02 1.931E+03 9.797E+00  
4.293E+00 2.653E+02 6.013E+02 1.643E+19 5.801E-04 4.223E+02 1.932E+03 9.797E+00  
4.561E+00 2.634E+02 5.809E+02 1.598E+19 5.095E-04 4.223E+02 1.934E+03 9.796E+00  
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1.173E+01 2.086E+02 2.062E+02 7.154E+18 1.206E-05 4.215E+02 1.904E+03 9.774E+00  
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1.616E+01 2.043E+02 9.841E+01 3.488E+18 1.929E-06 4.174E+02 1.789E+03 9.760E+00  
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1.779E+01 2.085E+02 7.520E+01 2.613E+18 1.929E-06 4.172E+02 1.783E+03 9.755E+00  
1.814E+01 2.081E+02 7.112E+01 2.475E+18 1.928E-06 4.173E+02 1.789E+03 9.754E+00  
1.848E+01 2.073E+02 6.719E+01 2.346E+18 1.927E-06 4.174E+02 1.794E+03 9.753E+00  
1.884E+01 2.066E+02 6.342E+01 2.222E+18 1.927E-06 4.174E+02 1.797E+03 9.752E+00  
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2.342E+01 2.144E+02 3.018E+01 1.019E+18 2.200E-06 4.098E+02 1.265E+03 9.738E+00  
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2.497E+01 2.177E+02 2.366E+01 7.870E+17 2.183E-06 4.101E+02 1.291E+03 9.733E+00  
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2.669E+01 2.210E+02 1.813E+01 5.941E+17 2.201E-06 4.102E+02 1.280E+03 9.728E+00  
2.731E+01 2.221E+02 1.651E+01 5.380E+17 2.224E-06 4.101E+02 1.253E+03 9.726E+00  
2.795E+01 2.233E+02 1.498E+01 4.855E+17 2.260E-06 4.100E+02 1.210E+03 9.724E+00  
2.861E+01 2.247E+02 1.355E+01 4.365E+17 2.304E-06 4.099E+02 1.160E+03 9.722E+00  
2.930E+01 2.260E+02 1.221E+01 3.911E+17 2.335E-06 4.098E+02 1.124E+03 9.720E+00  
3.002E+01 2.274E+02 1.097E+01 3.490E+17 2.359E-06 4.097E+02 1.096E+03 9.718E+00  
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3.155E+01 2.311E+02 8.752E+00 2.744E+17 2.409E-06 4.096E+02 1.046E+03 9.713E+00  
3.237E+01 2.320E+02 7.769E+00 2.426E+17 2.456E-06 4.095E+02 9.924E+02 9.711E+00  
3.321E+01 2.322E+02 6.865E+00 2.140E+17 2.498E-06 4.094E+02 9.408E+02 9.708E+00  
3.410E+01 2.324E+02 6.039E+00 1.881E+17 2.526E-06 4.093E+02 8.971E+02 9.706E+00  
3.501E+01 2.328E+02 5.285E+00 1.643E+17 2.561E-06 4.092E+02 8.449E+02 9.703E+00  
3.597E+01 2.333E+02 4.601E+00 1.427E+17 2.620E-06 4.091E+02 7.783E+02 9.700E+00  
3.697E+01 2.337E+02 3.983E+00 1.233E+17 2.691E-06 4.090E+02 7.060E+02 9.697E+00  
3.801E+01 2.340E+02 3.427E+00 1.059E+17 2.747E-06 4.088E+02 6.341E+02 9.694E+00  
3.910E+01 2.349E+02 2.930E+00 9.019E+16 2.790E-06 4.087E+02 5.714E+02 9.690E+00  
4.024E+01 2.363E+02 2.488E+00 7.621E+16 2.829E-06 4.087E+02 5.312E+02 9.687E+00  
4.144E+01 2.371E+02 2.097E+00 6.408E+16 2.861E-06 4.086E+02 4.966E+02 9.683E+00  
4.269E+01 2.364E+02 1.753E+00 5.373E+16 2.878E-06 4.085E+02 4.551E+02 9.679E+00  
4.400E+01 2.343E+02 1.454E+00 4.487E+16 2.883E-06 4.084E+02 4.135E+02 9.676E+00  
4.536E+01 2.322E+02 1.194E+00 3.718E+16 2.891E-06 4.083E+02 3.757E+02 9.671E+00  
4.678E+01 2.305E+02 9.716E-01 3.044E+16 2.898E-06 4.083E+02 3.549E+02 9.667E+00  
4.826E+01 2.299E+02 7.821E-01 2.455E+16 2.879E-06 4.083E+02 3.458E+02 9.663E+00  
4.982E+01 2.306E+02 6.224E-01 1.952E+16 2.820E-06 4.083E+02 3.394E+02 9.658E+00  
5.147E+01 2.304E+02 4.892E-01 1.540E+16 2.792E-06 4.083E+02 3.392E+02 9.653E+00  
5.320E+01 2.268E+02 3.793E-01 1.214E+16 2.814E-06 4.083E+02 3.408E+02 9.648E+00  
5.499E+01 2.189E+02 2.899E-01 9.581E+15 2.818E-06 4.083E+02 3.410E+02 9.642E+00  
5.681E+01 2.095E+02 2.180E-01 7.475E+15 2.781E-06 4.083E+02 3.410E+02 9.637E+00  
5.867E+01 2.042E+02 1.611E-01 5.642E+15 2.729E-06 4.083E+02 3.275E+02 9.631E+00  
6.063E+01 2.058E+02 1.168E-01 4.070E+15 2.557E-06 4.080E+02 2.857E+02 9.625E+00  
6.277E+01 2.110E+02 8.287E-02 2.829E+15 2.175E-06 4.078E+02 2.392E+02 9.619E+00  
6.510E+01 2.158E+02 5.747E-02 1.919E+15 1.752E-06 4.076E+02 2.138E+02 9.612E+00  
6.764E+01 2.188E+02 3.884E-02 1.275E+15 1.440E-06 4.076E+02 2.050E+02 9.605E+00  
7.041E+01 2.216E+02 2.551E-02 7.593E+14 1.229E-06 4.076E+02 2.040E+02 9.596E+00  
7.393E+01 2.219E+02 1.500E-02 6.160E+14 1.044E-06 4.075E+02 2.040E+02 9.586E+00