ICON Data Product 2.4: FUV Limb Daytime

This document describes the data product for ICON FUV Daytime, which is in NetCDF4 format.

This describes the data product for ICON FUV Limb Daytime O/N2 (DP 2.4),
which is in NetCDF4 format.
The ratio of oxygen to nitrogen in the thermosphere is obtained from the two channels of ICON FUV instrument data in,
through an inversion process described in https://doi.org/10.1007/s11214-018-0477-6.
NOTE: In this file, only the limb parameters are included.
These files are named ICON_L2-4_FUV_Day_Limb_YYYY-MM-DD_vXXrZZZ.NC, where YYYY-MM-DD is the year month day and vXX shows the version number
and ZZZ shows the revision number of this file. Each individual file nominally contains 1 day (24 hours) of data. The L2 FUV Limb Daytime
files are produced from the L1 FUV files.
In addition, many other parameters and geophysical data products are included in the file.
All variables within the file are described in their Var_notes attribute. The data are identified in one of 3 var_types: data – which
contains the primary data product; support data – which contains parameters used in the retrieval such as geometry etc. that may also
be useful in any analysis of this data; and ignore_data – which are recorded for debugging purposes and should not be used for publication
without detailed discussion with the ICON team.
The dimensions of the data also indicate its type. For example, anything with epoch as a dimension means there is 1 value corresponding
to each instrument exposure. Anything with dimension Input_data corresponds to the input data, passed from Level 1.
Anything with dimension altitude corresponds to the altitude grid used for the inverted parameters.

History

Version 001, Frist public release, limb data only. S. L. England
Version 001, First release version that uses the limb radiances to compute O/N2, and altitude profiles of O, N2 and similar. S. L. England, R. R. Meier

Dimensions

NetCDF files contain **variables** and the **dimensions** over which those variables are defined. First, the dimensions are defined, then all variables in the file are described.

The dimensions used by the variables in this file are given below, along with nominal sizes. Note that the size may vary from file to file. For example, the "Epoch" dimension, which describes the number of time samples contained in this file, will have a varying size.

Dimension Name	**Nominal Size**
`Epoch`	7007
`Input Data`	50
`Limb Altitude Grid`	22
`Limb Retrieval Flag`	3

Variables

Variables in this file are listed below. First, "data" variables are described, followed by the "support_data" variables, and finally the "metadata" variables. The variables classified as "ignore_data" are not shown.

data

Variable Name	Description	Units	Dimensions
ICON_L24_O	Retrieved altitude grid atomic O Retrieved altitude profile of O from the retrieval, in cm-3, as a function of altitude and time.	cm-3	Epoch, Limb Altitude Grid
ICON_L24_N2	Retrieved altitude grid molecular N2 Retrieved altitude profile of N2 from the retrieval, in cm-3, as a function of altitude and time.	cm-3	Epoch, Limb Altitude Grid
ICON_L24_O2	Retrieved altitude grid molecular O2 Retrieved altitude profile of O2 from the retrieval, in cm-3, as a function of altitude and time.	cm-3	Epoch, Limb Altitude Grid
ICON_L24_Temperature	Retrieved altitude grid temperature Retrieved altitude profile of temperature from the retrieval, in K, as a function of altitude and time.	K	Epoch, Limb Altitude Grid
ICON_L24_Sigma_O	Retrieved altitude grid sigma atomic O 1 standard deviation of the retrieved O from the retrieval, as a function of altitude and time. The data product uncertainties are based on the measurement counting statistics and are lower limits because systematic uncertainties, which are expected to be much larger, are not included. The data processing complexity requires a qualitatively new uncertainty approach that must be derived from first principles.	cm-3	Epoch, Limb Altitude Grid
ICON_L24_Sigma_N2	Retrieved altitude grid sigma molecular N2 1 standard deviation of the retrieved N2 from the retrieval, as a function of altitude and time. The data product uncertainties are based on the measurement counting statistics and are lower limits because systematic uncertainties, which are expected to be much larger, are not included. The data processing complexity requires a qualitatively new uncertainty approach that must be derived from first principles.	cm-3	Epoch, Limb Altitude Grid
ICON_L24_Sigma_O2	Retrieved altitude grid sigma molecular O2 1 standard deviation of the retrieved O2 from the retrieval, as a function of altitude and time. The data product uncertainties are based on the measurement counting statistics and are lower limits because systematic uncertainties, which are expected to be much larger, are not included. The data processing complexity requires a qualitatively new uncertainty approach that must be derived from first principles.	cm-3	Epoch, Limb Altitude Grid

Variable Name	Description	Units	Dimensions
ICON_L24_Sigma_O_N2	Retrieved sigma O/N2 1 standard deviation of the retrieved O/N2 from the retrieval, as a function of time. The data product uncertainties are based on the measurement counting statistics and are lower limits because systematic uncertainties, which are expected to be much larger, are not included. The data processing complexity requires a qualitatively new uncertainty approach that must be derived from first principles.	dimensionless	Epoch
ICON_L24_Sigma_Temperature	Retrieved altitude grid sigma temperature 1 standard deviation of the retrieved temperature from the retrieval, as a function of altitude and time. The data product uncertainties are based on the measurement counting statistics and are lower limits because systematic uncertainties, which are expected to be much larger, are not included. The data processing complexity requires a qualitatively new uncertainty approach that must be derived from first principles.	K	Epoch, Limb Altitude Grid
ICON_L24_Column_O_N2	Retrieved column O/N2 Retrieved column O/N2 from the limb data, as a function of time.	dimensionless	Epoch

support_data

Variable Name	Description	Units	Dimensions
Epoch	Milliseconds since 1970-01-01 00:00:00 UTC Time corresponding to the center of each observation, in milliseconds since Jan 1 1970.	milliseconds	Epoch
ICON_L24_UTC_Time	Date and Time in UTC format UTC time corresponding to the retrieved parameters, in string format, as a function of time, in the format: 2017-05-27/00:00:01.435	string	Epoch
ICON_L24_Latitude	Retrieved Latitude Latitude of the retrieval, defined at 150 km tangent altitude, in WGS	degrees	Epoch
ICON_L24_Longitude	Retrieved Longitude Longitude of the retrieval, defined at 150 km tangent altitude, in WGS	degrees	Epoch
ICON_L24_Local_Solar_Time	Retrieved local time Local solar time of the retrieval, defined at 150 km tangent altitude, in WGS	hours	Epoch
ICON_L24_F107	F10.7 used in retreival Unscaled value of F10.7 used as an input to the inversion process, as a function of time. These data are from ftp://ftp.seismo.nrcan.gc.ca/spaceweather/solar_flux/fluxtable.txt. These are the solar radio flux values tabulated from the Space Weather Canada which is a part of Natural Resources Canada.	sfu	Epoch

Variable Name	Description	Units	Dimensions
ICON_L24_Ap	Ap used in retreival Value of Ap used in the forward model, as a function of time. These data are from http://www-app3.gfz-potsdam.de/kp_index/. These are the tabulated Kp values from GFZ German Research Centre for Geosciences at the Helmholtz Centre Potsdam.	index	Epoch
ICON_L24_Solar_Zenith_Angle	Retrieved solar zenith angle Solar zenith angle of the retrieval, defined at 150 km tangent altitude, in WGS	degrees	Epoch
ICON_L24_Altitude	Retrieved altitude grid Altitude grid used by the retrieval, in WGS, as a function of time.	km	Epoch, Limb Altitude Grid
ICON_L24_Observatory_Latitude	Observatory Latitude Geodetic latitude (WGS84) of the spacecraft at the time corresponding to the middle of each FUV image, in degrees	degrees	Epoch
ICON_L24_Observatory_Longitude	Observatory Longitude Geodetic longitude (WGS84) of the spacecraft at the time corresponding to the middle of each FUV image, in degrees	degrees	Epoch
ICON_L24_Observatory_Altitude	Observatory Altitude Geodetic altitude (WGS84) of the spacecraft at the time corresponding to the middle of each FUV image, in kilometers	km	Epoch
ICON_L24_Instrument_Mode_Flag	Data collection mode Data collection mode of FUV instrument 1 = Dayside science 2 = Nightside science 3 = Calibration 4 = Nadir 5 = Conjugate 6 = Stars 7 = Ram 8 = Off Target 9 = Engineering 13 = Unknown	N/A	Epoch

Variable Name	Description	Units	Dimensions
ICON_L24_Level_1_Quality_Flag	Quality indicator (also quickly shows times when images are available) QUALITY_FLAG is an indicator of data quality = 0 = No errors or quality conditions, LVLH 1 = No errors or quality conditions, R-LVLH 2 = Lunar calibration 3 = Insufficient high voltage 4 = Nadir calibration 5 = Zero wind calibration 6 = Bad pointing 7 = S/C attitude slew 8 = Conjugate observation 9 = Stellar calibration 10 = Unreliable background subtracted 17 = unspecified error condition	N/A	Epoch
ICON_L24_Limb_Retrieval_Flags	Limb Retrieval Flags Limb retrieval quality flag, where 0 = no limb inversion, 1 = retrieval nominal, 2 = number of iterations in retrieval algorithm reaches 10 without convergence, 3 = one or more inversion model parameters hits a priori upper or lower limit, 4 = altitude of peak intensity too close to boundary, 5 = standard deviation of one or more variables exceeds expected limit, 6 = Chi-squared value is outside of expected range - either too large or too small, 7 = one or more uncertainties is outside of expected range.	integer	Epoch
ICON_L24_Whole_Day_Retrieval_Flag	Whole Day Retrieval Flags Single flag set for whole day, where 0 = nominal data set, 1 = whole day skipped because no solar zenith angles were within range.	Integer	

Acknowledgement

This is a data product from the NASA Ionospheric Connection Explorer mission, an Explorer launched in 2019.

Guidelines for the use of this product are described in the ICON Rules of the Road (https://http://icon.ssl.berkeley.edu/Data).

Responsibility for the mission science falls to the Principal Investigator, Dr. Thomas Immel at UC Berkeley:
Immel, T.J., England, S.L., Mende, S.B. et al. Space Sci Rev (2018) 214: 13. https://doi.org/10.1007/s11214-017-0449-2

Responsibility for the validation of the L1 data products falls to the instrument lead investigators/scientists.
* EUV: Dr. Eric Korpela : https://doi.org/10.1007/s11214-017-0384-2
* FUV: Dr. Harald Frey : https://doi.org/10.1007/s11214-017-0386-0
* MIGHTI: Dr. Christoph Englert : https://doi.org/10.1007/s11214-017-0358-4, and
https://doi.org/10.1007/s11214-017-0374-4
* IVM: Dr. Roderick Heelis : https://doi.org/10.1007/s11214-017-0383-3

Responsibility for the validation of the L2 data products falls to those scientists responsible for those products.
* Daytime O and N2 profiles: Dr. Andrew Stephan : https://doi.org/10.1007/s11214-018-0477-6
* Daytime (EUV) O+ profiles: Dr. Andrew Stephan : https://doi.org/10.1007/s11214-017-0385-1
* Nighttime (FUV) O+ profiles: Dr. Farzad Kamalabadi : https://doi.org/10.1007/s11214-018-0502-9
* Neutral Wind profiles: Dr. Jonathan Makela : https://doi.org/10.1007/s11214-017-0359-3
* Neutral Temperature profiles: Dr. Christoph Englert : https://doi.org/10.1007/s11214-017-0434-9
* Ion Velocity Measurements : Dr. Russell Stoneback : https://doi.org/10.1007/s11214-017-0383-3

Responsibility for Level 4 products falls to those scientists responsible for those products.
* Hough Modes : Dr. Chihoko Yamashita : https://doi.org/10.1007/s11214-017-0401-5
* TIEGCM : Dr. Astrid Maute : https://doi.org/10.1007/s11214-017-0330-3
* SAMI3 : Dr. Joseph Huba : https://doi.org/10.1007/s11214-017-0415-z

Pre-production versions of all above papers are available on the ICON website.

Overall validation of the products is overseen by the ICON Project Scientist, Dr. Scott England.

NASA oversight for all products is provided by the Mission Scientist, Dr. Ruth Lieberman.

Users of these data should contact and acknowledge the Principal Investigator Dr. Immel and the party directly responsible for the data product (noted above) and acknowledge NASA funding for the collection of the data used in the research with the following statement : "ICON is supported by NASA’s Explorers Program through contracts NNG12FA45C and NNG12FA42I".

These data are openly available as described in the ICON Data Management Plan available on the ICON website (http://icon.ssl.berkeley.edu/Data).