

ICON Data Product 2.4: FUV Daytime

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

This describes the data product for ICON FUV 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,

through an inversion process described in <https://doi.org/10.1029/2020JA029059>.

NOTE: In this file, only the disk parameters are included.

These files are named ICON_L2-4_FUV_Day_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 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 a

dimension of model refers to the forward model parameters used as part of the inversion.

History

Version 003, First public release, disk data only. S. L. England

Version 004, Updated to account for changes made to Level 1 files in version 05

(changes to background, radiances at Level 1). S. L. England, R. R. Meier

Version 005 and 006 represented no intended change to the disk product.

Version 007, Update to account for implementation of scattering correction. 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	5812
Model Initial Values	13
Input Data	128
Disk Retrieval Flag	3

Dimension Name	Nominal Size
Covariance Matrix 1st Dimension	13
Covariance Matrix 2nd Dimension	13

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_Disk_ON2	Retrieved disk column O/N2 Retrieved column O/N2 ratio on the disk	Dimensionless	Epoch
ICON_L24_Disk_Sigma_ON2	Retrieved disk column O/N2 uncertainty Uncertainty in retrieved column O/N2 ratio on the disk, based on spread in reported uncertainty in input data	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_F107	F10.7 used in retrieval 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
ICON_L24_Ap	Ap used in retrieval 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_Disk_Magnetic_Latitude	Magnetic Latitude on Disk Quasi-Dipole Magnetic Latitude at 150 km at Disk Retrieval location, in degrees	degrees	Epoch
ICON_L24_Disk_Magnetic_Longitude	Magnetic Longitude on Disk Quasi-Dipole Magnetic Longitude at 150 km at Disk Retrieval location, in degrees	degrees	Epoch

Variable Name	Description	Units	Dimensions
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_1356_Emission	Disk short wave emission Short wave disk column emission rate	Rayleighs	Epoch
ICON_L24_LBH_Emission	Disk long wave emission Long wave disk column emission rate	Rayleighs	Epoch
ICON_L24_Disk_Latitude	Retrieved disk latitude Geodetic latitude (WGS84) corresponding to disk retrieval	Degrees	Epoch
ICON_L24_Disk_Longitude	Retrieved disk longitude Geodetic longitude (WGS84) corresponding to disk retrieval	Degrees	Epoch
ICON_L24_Disk_SZA	Retrieved disk SZA Solar zenith angle corresponding to disk retrieval	Degrees	Epoch
ICON_L24_Local_Solar_Time_Disk	Local time on the disk Local solar time of the retrieval on the disk, in hours	hours	Epoch
ICON_L24_Disk_LOS_Zen_Angle	Retrieved disk LOS zenith angle Line of sight zenith angle corresponding to disk retrieval	Degrees	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_Disk_Retrieval_Flags	Disk Retrieval Flags Disk retrieval quality flag, where 0 = nominal retrieval, 1 = Disk short/long wave ratio out of model range, 2 = Disk O/N2 value out of expected range, 3 = Disk P/N2 uncertainty out 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 at 21:59:45 EDT on October 10, 2019, from Cape Canaveral AFB in the USA. Guidelines for the use of this product are described in the ICON Rules of the Road (<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> Immel, T.J., England, S.L., Harding, B.J. et al. Space Sci Rev (2023) 219: 41. <https://doi.org/10.1007/s11214-023-00975-x>

Responsibility for the validation of the L1 data products falls to the instrument lead investigators/scientists. EUV: Dr. Martin Sirk and Dr. Eric Korpela : <https://doi.org/10.1007/s11214-023-00963-1>, and <https://doi.org/10.1007/s11214-017-0384-2> FUV: Dr. Harald Frey : <https://doi.org/10.1007/s11214-023-00969-9>, and <https://doi.org/10.1007/s11214-017-0386-0> MIGHTI: Dr. Christoph Englert : <https://doi.org/10.1007/s11214-023-00971-1>, <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/N2 ratio : Dr. Robert Meier : <https://doi.org/10.1007/s11214-018-0477-6>
- * Daytime (EUV) O+ profiles: Dr. Andrew Stephan : <https://doi.org/10.1007/s11214-022-00933-z>, and <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. Brian Harding : <https://doi.org/10.1007/s11214-017-0359-3>, and <https://doi.org/10.1029/2020JA028947>
- * Neutral Temperature profiles: Dr. Michael Stevens : <https://doi.org/10.1007/s11214-022-00935-x>, and <https://doi.org/10.1007/s11214-017-0434-9>
- * Ion Velocity Measurements : Dr. Roderick Heelis : <https://doi.org/10.1007/s11214-017-0383-3>

Additional theoretical work in support of these products was supported by Dr. Robert Meier
Daytime O/N2 product <https://doi.org/10.1029/2020JA029059>
Daytime (EUV) O+ profiles : <https://doi.org/10.1029/2023JA031533>

Additional validation work was performed by Dr. Jonathan Makela, Dr. Gilles Wautelet, and Dr. Yen-Jung (Joanne) Wu:
Neutral wind profiles : <https://doi.org/10.1029/2020JA028726>
Nighttime (FUV) O+ profiles : <https://doi.org/10.1007/s11214-023-00970-2>
Daytime (EUV) O+ profiles : <https://doi.org/10.1007/s11214-022-00930-2>
Ion Velocity Measurements : <https://doi.org/10.1007/s11214-023-00993-9>

Responsibility for Level 4 products falls to those scientists responsible for those products.

- * Hough Modes : Dr. Chihoko Cullens : <https://doi.org/10.1186/s40645-020-00330-6> and <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.
<http://icon.ssl.berkeley.edu/Publications>

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. Jeffrey Klenzing (2018-2022) and Dr. Ruth Lieberman (2022-present).

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 on the ICON website (<http://icon.ssl.berkeley.edu/Data>).

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