

ICON Data Product 3.4: FUV Sublimb Time Delay and Integration Maps

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

This describes the data product for ICON FUV Time Delay and Integration (TDI) sublimb nighttime images, which is in NetCDF4 format.

The TDI images are obtained from the 135.6 nm channel of ICON FUV instrument data, through an inversion process described in <https://doi.org/10.1007/s11214-022-00928-w>

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

These files are named ICON_L3-4_Ionosphere-Image_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 L3.4 FUV Sublimb Nighttime TDI

files are produced from the L1 FUV files (ICON_L1_FUV_SSI_YYYY-MM-DD_vXXrZZZ.NC) and LOP Ephemeris files.

The FUV TDI Shortwave Sublimb Image files (SSI) contain the individual TDI images. Each image is projected, assuming an altitude of 300km, onto a map using IDL's build-in MAP_IMAGE function.

The ephemeris data are used for ICON's location and the look direction of each TDI image. It is assumed that ICON is in a circular orbit at 600 km altitude.

Pixels in the TDI images that overlap are integrated and normalized by the number of overlapping images. Each nighttime pass is sampled into

a 0.25 degree x 0.25 degree latitude/longitude grid and median smoothed by 5 pixels by 11 pixels to produce the highest resolution image possible given the integration time

and overlap of the individual TDI images.

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 the middle epoch value of each orbit. 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 01, Created by L3.4 Sublimb processor v3 on Wed, 20 May 2026, 2026-05-20T04:43:18.616 UTC

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	16
ICON_L34_Latitude	321
ICON_L34_Longitude	1440

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_L34_TDI_Image	TDI images of one days worth of nighttime orbits over the sublimb. The intensities of the FUV nighttime sublimb image after they have been through a TDI process.	Rayleighs	ICON_L34_Longitude, ICON_L34_Latitude, Epoch
ICON_L34_Start_Time	The start time for the full nighttime orbit for each orbit of the day. The start time for the full nighttime orbit for each orbit of the day.	UTC	Epoch
ICON_L34_End_Time	The end time for the full nighttime orbit for each orbit of the day. The end time for the full nighttime orbit for each orbit of the day.	UTC	Epoch

support_data

Variable Name	Description	Units	Dimensions
Epoch	Milliseconds since 1970-01-01 00:00:00 UTC at middle of the TDI Orbit Swath. Number of milliseconds since 1970-01-01 00:00:00 UTC at the middle of the TDI Orbit Swath.	milliseconds	Epoch
ICON_L34_TIME_UTC	UTC time corresponding to the Epoch at middle of the TDI Orbit Swath. UTC time corresponding to the Epoch at the middle of the TDI Orbit Swath.	UTC	Epoch
ICON_L34_Latitude	Latitudes of the TDI image. The Geocentric Latitudes of each TDI image for the day. All latitudes for the day are included.	degrees North	ICON_L34_Latitude
ICON_L34_Longitude	Longitudes of the TDI image. The Geocentric Longitudes of each TDI image for the day. All longitudes for the day are included.	degrees East	ICON_L34_Longitude

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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Software version: ICON SDC > FUV 1

NOTE: There can be stellar contamination in the TDI images. Stars have not been removed and can appear as bow-like structures in the images or other stationary local time structures. These are NOT ionospheric in nature. See Figure below for an example of stellar contamination. To check if there is a stellar contamination, the FUV L1 SWP files contain a variable ICON_L1_FUVA_SWP_PROF_P0 (not the _CLEAN variable) which will contain stars. All six stripe variables in the L1 SWP files will contain the stars as well.

