ICON Data Product 2.6: EUV Daytime Ionosphere

This document describes the data product for ICON EUV L2.6 derived daytime ionosphere products, which is in NetCDF4 format.

This describes the data product for ICON EUV Daytime Ionosphere (DP 2.6), which is in NetCDF4 format. These files are named ICON_L2-6_EUV_YYYY-MM-DD_vXXrZZZ.NC, where YYYY-MM-DD is the year month day, XX shows the version number and ZZZ shows the revision number of this file. Each individual file contains one calendar day (24 hours) of data. The L2 EUV Daytime files are produced from the L1 EUV files and corresponding Ancillary (Level 0-prime) files. Their primary data products are ionospheric O+ density profiles derived from a retrieval detailed in Stephan et al. (2017), https://doi.org/10.1007/s11214-017-0385-1. As part of this, an estimation is made of electron density hmF2 and NmF2 values using the IRI 2007 model that underlies the retrieval algorithm. The corresponding full electron density profiles are not explicitly included as a data product at this time. The data files also include many other related parameters and geophysical data products. The variables within the file are all described in their Var_notes attribute.

The data are identified as one of three Var_types: data – which contains the primary data products; support_data – which contains parameters used in the retrieval such as viewing geometry etc. that may also be useful in any analysis of these 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 the connection between the variable and its source. For example, anything with a dimension of Epoch means there is one value corresponding to each instrument exposure. Anything with dimension Input_data corresponds to the input data passed from EUV Level 1. Anything with a dimension of Model refers to the forward model parameters used as part of the inversion (typically only present in ignore_data types). Anything with dimension Altitude corresponds to the altitude grid used for the retrieved density profiles.

History

Version 02. Initial public release. A. W. Stephan 2020-04-17.
Version 02 Rev 01. Updated release of v02 code with adaptations for corrected EUV ancillary data (v02), and minor code performance improvements. A.W. Stephan 2021-07-21.
*** NOTE: Only Version 03 and later should be used for scientific studies.***
Version 03. Updated release for clean reprocessing of EUV L1 (v03) data to L2 v03. A.W. Stephan 2021-11-16.
Version 03 Rev 01. Updated data quality flags. A.W. Stephan 2022-07-20.

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	1872
Model	5
Input_Data	67
Altitude	72
Vectors	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_L26_HmF2	HmF2 Height of the peak electron density of the F2 layer from retrieval, in WGS. The relationship between retrieved O+ and electron densities is inferred using IRI2007.	km	Epoch
ICON_L26_NmF2	NmF2 Electron density at the peak of the F2 layer from retrieval. The relationship between retrieved O+ and electron densities is inferred using IRI2007.	cm-3	Epoch
ICON_L26_Sigma_HmF2	Sigma HmF2 1-sigma uncertainty in height of the F2 layer peak from retrieval, as determined from the reported statistical uncertainties of the measurements	km	Epoch
ICON_L26_Sigma_NmF2	Sigma NmF2 1-sigma uncertainty in electron density at the peak of the F2 layer from retrieval as determined from the reported statistical uncertainties of the measurements	cm-3	Epoch
ICON_L26_Flag	Retrieval Flag Quality flag associated with the L2 retrieval and/or L1 data. 0 = No issues reported, 1 = Moderate issue(s) identified, use results with caution, 2 = Severe issue(s) identified, recommend not using data product for this profile. See the ICON_L26_Flag_Details variable for additional information for the reported causes on any non-zero values	N/A	Epoch
ICON_L26_Oplus	O+ Profile Number density of O+ as a function of altitude from the retrieval	cm-3	Epoch, Altitude
ICON_L26_Sigma_Oplus	Sigma O+ Profile 1-sigma uncertainty in the number density of O+ as a function of altitude from the retrieval as determined from the reported statistical uncertainties of the measurements	cm-3	Epoch, Altitude

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_L26_Observatory_Altitude	WGS84 Altitude of Spacecraft Position (Geodetic) Altitude of the spacecraft at the time of data collection, in WGS84	km	Epoch
ICON_L26_Observatory_Latitude	WGS84 Latitude of Spacecraft Position (Geodetic) Geographic latitude of the spacecraft at the time of data collection, in WGS84	degrees North	Epoch
ICON_L26_Observatory_Longitude	WGS84 Longitude of Spacecraft Position (Geodetic) Geographic longitude of the spacecraft at the time of data collection, in WGS84	degrees East	Epoch
ICON_L26_Orbit_Number	Orbit Number Integer orbit number of the ICON spacecraft, incremented throughout the mission	integer	Epoch
ICON_L26_Observatory_ECEF	Spacecraft Position in ECEF Coordinates Location of the spacecraft in ECEF coordinates at the time of data collection. Dimension corresponding to the X, Y, Z components of Cartesian vector.	km	Epoch, Vectors
ICON_L26_UTC_Time	Date and Time in UTC format UTC time corresponding to the measurement used in the retrieval	string	Epoch
ICON_L26_F107	F10.7 values used The daily F10.7 values used in the retrieval, in solar flux units. The data are obtained directly from The Solar Radio Monitoring Program through Natural Resources Canada (https://www.spaceweather.gc.ca/solarflux/sx-en.php).	sfu	Epoch
ICON_L26_F107a	F10.7a values used Custom F10.7a value used in the retrieval, in solar flux units. This value is constructed at the ICON Science Data Center and is meant to provide a timely approximation to the 81-day F10.7a average used in atmospheric models, but is centered on a date 33 days prior to the ICON measurement, specifically encompassing F10.7 data from 73 days prior to 7 days after the measurement.	sfu	Epoch
ICON_L26_Ap	Ap values used Value of the Ap index used in the retrieval, from GPI file.	Index	Epoch
ICON_L26_Latitude	Geodetic Latitude Geodetic latitude at retrieval location, referenced at 300 km altitude, in WGS	degrees	Epoch

Variable Name	Description	Units	Dimensions
ICON_L26_Longitude	Geodetic Longitude Geodetic longitude at retrieval location, referenced at 300 km altitude, in WGS	degrees	Epoch
ICON_L26_Magnetic_Latitude	Magnetic Latitude Quasi-dipole magnetic latitude at retrieval location, referenced at 300 km, calculated using the fast implementation developed by Emmert et al. (2010, doi:10.1029/2010JA015326) and the Python wrapper apexpy (https://github.com/aburrell/apexpy/).	degrees	Epoch
ICON_L26_Magnetic_Longitude	Magnetic Longitude Quasi-dipole magnetic longitude at retrieval location, referenced at 300 km, calculated using the fast implementation developed by Emmert et al. (2010, doi:10.1029/2010JA015326) and the Python wrapper apexpy (https://github.com/aburrell/apexpy/).	degrees	Epoch
ICON_L26_Year_DOY	Integer Year DOY Year and Day of Year corresponding to the retrieval, in the format of YYYYDOY	day	Epoch
ICON_L26_Earth_Radius	Re_Retrieval Local Earth radius at retrieval location, from WGS	km	Epoch
ICON_L26_Local_Solar_Time	Local Solar Time Local solar time at retrieval location	hours	Epoch
ICON_L26_Solar_Zenith_Angle	Solar Zenith Angle Solar zenith angle at retrieval location.	degrees	Epoch
ICON_L26_Flag_Details	Retrieval Flag Details Provides additional detail on issues in the retrieval that resulted in a data quality flag of seriousness level 1 (moderate) or 2 (severe), as contained in the ICON_L26_Flag variable.	string	Epoch
ICON_L26_UT_Seconds	UT Seconds UTC time in seconds since midnight corresponding to the time of the measurement used in the retrieval	seconds	Epoch
ICON_L26_Altitude	Retrieval Altitude Altitude corresponding to the retrieved quantities, in WGS84	km	Epoch, Altitude

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

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