

ICON Data Product 0P: FUV Ancillary Products

This document describes the data product for Ancillary Products for FUV Data Processing, which is in NetCDF4 format.

The FUV ancillary data file contains information on the ICON observatory as well as FUV specific information. This includes the pointing, position, and velocity of the ICON observatory. It also includes information on the status of the observatory such as maneuvers, being in or out of the Earth's shadow, and calibrations. Pertinent information for the FUV instrument is included such as locations and details at the FUV tangent points. These files are combined with the FUV Level 1 data to produce Level 2 data. Variables labeled FUVA are for the short wave data only. Variables labeled FUVB are for the long wave data only. Variables label FUV are for both. ECEF is Earth-centered, Earth-fixed reference frame. ECI is Earth-centered inertial reference frame. We use the J2000 ECI frame. LVLH is local-vertical, local-horizontal. We have two LVLH modes: normal and reverse. LVLH Normal is when the spacecraft is looking north with latitude tangent locations between ~12 S and ~42 N. LVLH Reverse is when the spacecraft is looking south with latitude tangent locations between ~42 S and ~12 N.

History

Version 03, Created by FUV Ancillary Processor v3.0.2 on Thu, 08 Oct 2020, 2020-10-08T18:28:41.000 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	7013
HORIZONTAL	6
VERTICAL	256
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.

support_data

Variable Name	Description	Units	Dimensions
EPOCH	<p>Milliseconds since 1970-01-01 00:00:00 UTC at middle of measurement integration.</p> <p>Number of milliseconds since 1970-01-01 00:00:00 UTC at the middle of the measurement integration.</p>	milliseconds	EPOCH
ICON Ancillary FUV Time UTC	<p>Date and Time in UTC format</p> <p>ISO 8601 formatted UTC timestamp (at middle of reading). E.g., 2017-05-27 00:00:00.380Z</p>	UTC	EPOCH
ICON Ancillary FUV SC Position ECEF	<p>Spacecraft Position in ECEF Coordinates</p> <p>Position of spacecraft in ECEF coordinates.</p>	km	EPOCH, VECTORS
ICON Ancillary FUV Latitude	<p>WGS84 Latitude of Spacecraft Position (Geodetic)</p> <p>Geodetic Latitude of Spacecraft in WGS84</p>	degrees North	EPOCH
ICON Ancillary FUV Longitude	<p>WGS84 Longitude of Spacecraft Position (Geodetic)</p> <p>Geodetic Longitude of Spacecraft in WGS84</p>	degrees East	EPOCH
ICON Ancillary FUV Altitude	<p>WGS84 Altitude of Spacecraft Position (Geodetic)</p> <p>Geodetic Altitude of Spacecraft in WGS84</p>	km	EPOCH
ICON Ancillary FUV SC SZA	<p>Spacecraft Solar Zenith Angle</p> <p>Solar Zenith Angle at the spacecraft</p>	degrees	EPOCH
ICON Ancillary FUV SUN STATUS	<p>Spacecraft Sun/Shadow Status Code</p> <p>Binary flag indicating if the spacecraft is in the sun or shadow, where 1 = shadow, 0 = sun</p>	binary	EPOCH
ICON Ancillary FUV ORBIT NUMBER	<p>Orbit Number</p> <p>Integer Orbit Number</p>	integer	EPOCH

Variable Name	Description	Units	Dimensions
ICON Ancillary_FUV_SLEW_STATUS	Slew or off-point Status Code Binary Coded Integer where 1: LVLH Normal Mode 2: LVLH Reverse Mode 4: Earth Limb Pointing 8: Inertial Pointing 16: Stellar Pointing 32: Attitude Slew 64: Conjugate Maneuver 128: Nadir Calibration 256: Lunar Calibration 512: Stellar Calibration 1024: Zero Wind Calibration 2048-32768: SPARE	binary	EPOCH
ICON Ancillary_FUVA_TANGENTPOINTS_LATLONG	Tangent Locations of FUVA (SW) in WGS84 (Latitude, Longitude, Altitude) Location of tangent points in WGS84 for all 6 stripes and 256 vertical pixels for the shortwave channel. Locations are in Latitude, Longitude, Altitude.	mixed	EPOCH, VERTICAL, HORIZONTAL, VECTORS
ICON Ancillary_FUVA_TANGENTPOINTS_SZA	Tangent Points of FUVA (SW) Solar Zenith Angle Solar zenith angle at tangent points for all 6 stripes and 256 vertical pixels for the shortwave channel.	degrees	EPOCH, VERTICAL, HORIZONTAL
ICON Ancillary_FUVA_FOV_UNITVECTORS_ECEF	FOV Unit Vectors of FUVA (SW) in ECEF Unit look vectors in ECEF for all 6 stripes across the image and 256 vertical pixels for the shortwave channel.	dimensionless	EPOCH, VERTICAL, HORIZONTAL, VECTORS
ICON Ancillary_FUVA_HORIZONTAL_BORESIGHT_SUN_ANGLE	Horizontal Boresight of FUVA (SW) to Sun Angle Angle between the Sun and the horizontal plane at the center of the current instrument field of view for FUVA (Short Wave).	degrees	EPOCH
ICON Ancillary_FUVA_VERTICAL_BORESIGHT_SUN_ANGLE	Vertical Boresight of FUVA (SW) to Sun Angle Angle between the Sun and the vertical plane at the center of the current instrument field of view for FUVA (Short Wave).	degrees	EPOCH
ICON Ancillary_FUVA_TOTAL_BORESIGHT_SUN_ANGLE	Total Boresight of FUVA (SW) to Sun Angle Magnitude of the angle between the Sun and the boresight of the current instrument field of view for FUVA (Short Wave).	degrees	EPOCH
ICON Ancillary_FUVA_FOV_AZIMUTH_ANGLE	FUVA (SW) FOV Celestial Azimuth Celestial azimuth with respect to geographic north for all 6 stripes across the image and 256 vertical pixels for the shortwave channel.	degrees	EPOCH, VERTICAL, HORIZONTAL
ICON Ancillary_FUVA_FOV_ZENITH_ANGLE	FUVA (SW) FOV Celestial Zenith Celestial zenith with respect to geographic north for all 6 stripes across the image and 256 vertical pixels for the shortwave channel.	degrees	EPOCH, VERTICAL, HORIZONTAL

Variable Name	Description	Units	Dimensions
ICON Ancillary FUV Space Environment Region Status	<p>Space Environment Region Status</p> <p>Standardized for several missions, not all codes are relevant for ICON. Binary Coded Integer where</p> <ul style="list-style-type: none"> 1: Earth Shadow 2: Lunar Shadow 4: Atmospheric Absorption Zone 8: South Atlantic Anomaly 16: Northern Auroral Zone 32: Southern Auroral Zone 64: Periapsis Passage 128: Inner & Outer Radiation Belts 256: Deep Plasma Sphere 512: Foreshock Solar Wind 1024: Solar Wind Beam 2048: High Magnetic Field 4096: Average Plasma Sheet 8192: Bowshock Crossing 16384: Magnetopause Crossing 32768: Ground Based Observatories 65536: 2-Day Conjunctions 131072: 4-Day Conjunctions 262144: Time Based Conjunctions 524288: Radial Distance Region 1 1048576: Orbit Outbound 2097152: Orbit Inbound 4194304: Lunar Wake 8388608: Magnetotail 16777216: Magnetosheath 33554432: Science 67108864: Low Magnetic Latitude 134217728: Conjugate Observation 	binary	EPOCH
ICON Ancillary FUV Status	<p>FUV Status</p> <p>Binary Coded Integer where</p> <ul style="list-style-type: none"> 1: Earth Day View 2: Earth Night View 4: Calibration Target View 8: Off-target View 16: Sun Proximity View 32: Moon Proximity View 64: North Magnetic Footpoint View 128: South Magnetic Footpoint View 256: Science Data Collection View 512: Calibration Data Collection View 1024: RAM Proximity View 2048-32768: SPARE <p>Activity is what the spacecraft was commanded to do while status is the spacecraft's natural state of operations. This means that activity should always be used over status if they differ, but will almost always be the same.</p>	binary	EPOCH

Variable Name	Description	Units	Dimensions
ICON_ANCILLARY_FUV_ACTIVITY	<p>FUV Activity</p> <p>Binary Coded Integer of where</p> <p>1: Earth Day View 2: Earth Night View 4: Calibration Target View 8: Off-target View 16: Sun Proximity View 32: Moon Proximity View 64: North Magnetic Footpoint View 128: South Magnetic Footpoint View 256: Science Data Collection View 512: Calibration Data Collection View 1024: RAM Proximity View 2048-32768: SPARE</p> <p>Activity is what the spacecraft was commanded to do while status is the spacecraft's natural state of operations. This means that activity should always be used over status if they differ, but will almost always be the same.</p>	bianry	EPOCH
ICON_ANCILLARY_FUV_LOOK_AZIMUTH	<p>Look Azimuth</p> <p>Direction of nominal instrument pointing relative to spacecraft axes, in the yaw direction.</p>	degrees	EPOCH
ICON_ANCILLARY_FUV_LOOK_ROLL	<p>Look Roll</p> <p>Direction of nominal instrument pointing relative to spacecraft axes, in the roll direction.</p>	degrees	EPOCH
ICON_ANCILLARY_FUVA_PIERCEPOINTS_LATLONGALT_150	<p>FUVA (SW) Pierce Point Locations at 150 km in WGS84 (Latitude, Longitude, Altitude)</p> <p>Location of pierce points of a 150 km altitude surface in WGS84 for all 6 stripes across the image and 256 vertical pixels for the shortwave channel. Location is in Latitude, Longitude, Altitude.</p>	mixed	EPOCH, VERTICAL, HORIZONTAL, VECTORS
ICON_ANCILLARY_FUVA_PIERCEPOINTS_LATLONGALT_300	<p>FUVA (SW) Pierce Point Locations at 300 km in WGS84 (Latitude, Longitude, Altitude)</p> <p>Location of pierce points at 300 km altitude surface in WGS84 for all 6 stripes across the image and 256 vertical pixels for the shortwave channel. Location is in Latitude, Longitude, and Altitude.</p>	mixed	EPOCH, VERTICAL, HORIZONTAL, VECTORS
ICON_ANCILLARY_FUVA_PIERCEPOINTS_SZA_150	<p>FUVA (SW) Solar Zenith Angle of Pierce Points at 150 km</p> <p>Solar zenith angle of pierce points of a 150 km altitude surface for all 6 stripes across the image and 256 vertical pixels for the shortwave channel.</p>	degrees	EPOCH, VERTICAL, HORIZONTAL

Variable Name	Description	Units	Dimensions
ICON Ancillary_FUVA_PIERCEPOINTS_SZA_300	FUVA (SW) Solar Zenith Angle of Pierce Points at 300 km Solar zenith angle of pierce points of a 300 km altitude surface for all 6 stripes across the image and 256 vertical pixels for the shortwave channel.	degrees	EPOCH, VERTICAL, HORIZONTAL
ICON Ancillary_FUV_SUBSOLAR_LATITUDE	Subsolar Latitude Geodetic latitude of subsolar point, in WGS84.	degrees	EPOCH
ICON Ancillary_FUV_SUBSOLAR_LONGITUDE	Subsolar Longitude Geodetic longitude of subsolar point, in WGS84.	degrees	EPOCH
ICON Ancillary_FUV_TURRET_ANGLE	Turret Angle Position of the FUV turret with respect to nominal center position.	degrees	EPOCH
ICON Ancillary_FUVA_TANGENTPOINTS_LST	Tangent Points Local Solar Time of FUVA (SW) Local Solar Time at tangent points for all 6 stripes across the image and 256 vertical pixels for the shortwave channel.	hours, decimal	EPOCH, VERTICAL, HORIZONTAL
ICON Ancillary_FUVA_PIERCEPOINTS_LST_150	Local Solar Time at Pierce Points of FUVA (SW) at 150 km Local Solar Time at pierce points of a 150 km altitude surface for all 6 stripes across the image and 256 vertical pixels for the shortwave channel.	hours, decimal	EPOCH, VERTICAL, HORIZONTAL
ICON Ancillary_FUVA_PIERCEPOINTS_LST_300	Local Solar Time at Pierce Points of FUVA (SW) at 300 km Local Solar Time at pierce points of a 300 km altitude surface for all 6 stripes across the image and 256 vertical pixels for the shortwave channel.	hours, decimal	EPOCH, VERTICAL, HORIZONTAL
ICON Ancillary_FUVB_TANGENTPOINTS_LATLONGALT	Tangent Locations of FUVB (LW) in WGS84 (Latitude, Longitude, Altitude) Location of tangent points of in WGS84 for all 6 stripes across the image and 256 vertical pixels for the longwave channel. Locations are in Latitude, Longitude, Altitude.	mixed	EPOCH, VERTICAL, HORIZONTAL, VECTORS
ICON Ancillary_FUVB_TANGENTPOINTS_SZA	Tangent Points of FUVB (LW) Solar Zenith Angle Solar zenith angle at tangent points for all 6 stripes across the image and 256 vertical pixels for the longwave channel.	degrees	EPOCH, VERTICAL, HORIZONTAL
ICON Ancillary_FUVB_FOV_UNITVECTORS_ECEF	FOV Unit Vectors of FUVB (LW) in ECEF Unit vectors in ECEF for all 6 stripes across the image and 256 vertical pixels for the longwave channel.	dimensionless	EPOCH, VERTICAL, HORIZONTAL, VECTORS
ICON Ancillary_FUVB_HORIZONTAL_BORESIGHT_SUN_ANGLE	Horizontal Boresight of FUVB (LW) to Sun Angle Angle between the Sun and the horizontal plane at the center of the current instrument field of view for FUVB (Long Wave).	degrees	EPOCH

Variable Name	Description	Units	Dimensions
ICON Ancillary_FUVB_VERTICAL_BORESIGHT_SUN_ANGLE	Vertical Boresight of FUVB (LW) to Sun Angle Angle between the Sun and the vertical plane at the center of the current instrument field of view for FUVB (Long Wave).	degrees	EPOCH
ICON Ancillary_FUVB_TOTAL_BORESIGHT_SUN_ANGLE	Total Boresight of FUVB (LW) to Sun Angle Magnitude of the angle between the Sun and the boresight of the current instrument field of view for FUVB (Long Wave).	degrees	EPOCH
ICON Ancillary_FUVB_FOV_AZIMUTH_ANGLE	FUVB (LW) FOV Celestial Azimuth Celestial azimuth with respect to geographic north for all 6 stripes across the image and 256 vertical pixels for the longwave channel.	degrees	EPOCH, VERTICAL, HORIZONTAL
ICON Ancillary_FUVB_FOV_ZENITH_ANGLE	FUVB (LW) FOV Celestial Zenith Celestial zenith with respect to geographic north for all 6 stripes across the image and 256 vertical pixels for the longwave channel.	degrees	EPOCH, VERTICAL, HORIZONTAL
ICON Ancillary_FUVB_PIERCEPOINTS_LATLONGALT_150	FUVB (LW) Pierce Point Locations at 150 km in WGS84 (Latitude, Longitude, Altitude) Location of pierce points of a 150 km altitude surface in WGS84 for all 6 stripes across the image and 256 vertical pixels for the longwave channel. Location is in Latitude, Longitude, Altitude.	mixed	EPOCH, VERTICAL, HORIZONTAL, VECTORS
ICON Ancillary_FUVB_PIERCEPOINTS_LATLONGALT_300	FUVB (LW) Pierce Point Locations at 300 km in WGS84 (Latitude, Longitude, Altitude) Location of pierce points of a 300 km altitude surface in WGS84 for all 6 stripes across the image and 256 vertical pixels for the longwave channel. Location is in Latitude, Longitude, Altitude.	mixed	EPOCH, VERTICAL, HORIZONTAL, VECTORS
ICON Ancillary_FUVB_PIERCEPOINTS_SZA_150	FUVB (LW) Solar Zenith Angle of Pierce Points at 150 km Solar zenith angle of pierce points of a 150 km altitude surface for all 6 stripes across the image and 256 vertical pixels for the longwave channel.	degrees	EPOCH, VERTICAL, HORIZONTAL
ICON Ancillary_FUVB_PIERCEPOINTS_SZA_300	FUVB (LW) Solar Zenith Angle of Pierce Points at 300 km Solar zenith angle of pierce points of a 300 km altitude surface for all 6 stripes across the image and 256 vertical pixels for the longwave channel.	degrees	EPOCH, VERTICAL, HORIZONTAL
ICON Ancillary_FUVB_TANGENTPOINTS_LST	Tangent Points Local Solar Time of FUVB (LW) Local Solar Time at tangent points for all 6 stripes across the image and 256 vertical pixels for the longwave channel.	hours, decimal	EPOCH, VERTICAL, HORIZONTAL

Variable Name	Description	Units	Dimensions
ICON Ancillary FUVB Piercepoints LST_150	<p>Local Solar Time at Pierce Points of FUVB (LW) at 150 km</p> <p>Local Solar Time at pierce points of a 150 km altitude surface for all 6 stripes across the image and 256 vertical pixels for the longwave channel.</p>	hours, decimal	EPOCH, VERTICAL, HORIZONTAL
ICON Ancillary FUVB Piercepoints LST_300	<p>Local Solar Time at Pierce Points of FUVB (LW) at 300 km</p> <p>Local Solar Time at pierce points of a 300 km altitude surface for all 6 stripes across the image and 256 vertical pixels for the longwave channel.</p>	hours, decimal	EPOCH, VERTICAL, HORIZONTAL

Variable Name	Description	Units	Dimensions
ICON Ancillary FUV Quality Flag ICON Ancillary FUV Quality Flag	<p>Quality Flag</p> <p>Binary Coded Integer where</p> <p>1: STATE_NO_DATA 2: STATE_UNCONVERGED 4: STATE_LOW 8: STATE_MED 16: STATE_HIGH 32: AD_NO_DATA 64: AD_DIVERGING 128: AD_NOT_STARTED 256: AD_CONVERGING 512: AD_COARSE_CONVERGED 1024: AD_FINE_CONVERGED 2048-32768: SPARE</p> <p>STATE_NO_DATA: No telemetry available for this time period. States are propagated from the last valid solution.</p> <p>STATE_UNCONVERGED: The GOODS KF solution is unconverged and should not be used. States are propagated from the last valid solution.</p> <p>STATE_LOW: The GPSR solution is better than the GOODS solution (The position accuracy is worse than 150 m, 1-sigma)</p> <p>STATE_MEDIUM: The GOODS solution is better than the GPSR solution (The position accuracy is better than 150 m, 1-sigma)</p> <p>STATE_HIGH: The GOODS solution is better than the GPSR solution, and meets its performance requirements (20 m position and 0.02 m/sec velocity, 1-sigma).</p> <p>AD_NO_DATA: No telemetry available for this time period. Attitude is copied from the last valid solution.</p> <p>AD_DIVERGING: Tolerances on the diagonal elements of the covariance matrix diverging and exceeds 9.9e9 asec² for attitude sigma and 9.9e9 asec²/sec² for rate sigma or negative values</p> <p>AD_NOT_STARTED: KF has not started processing measurements</p> <p>AD_CONVERGING: KF is in state of updating measurements and filter started to converge</p> <p>AD_COARSE_CONVERGED: Tolerances on the diagonal elements of the covariance matrix converging and below 200K asec² for x, y and 1000K for z in tracker frame for attitude and 10 asec²/sec² for x, y and z for rate</p> <p>AD_FINE_CONVERGED: Tolerances on the diagonal elements of the covariance matrix converging and below 1000 asec² for x, y and z in tracker frame for attitude and 1 asec²/sec² x, y and z for rate</p> <p>Nominal value of 1040: STATE_HIGH (16) and AD_FINE_CONVERGED (1024). All values are a combination of a STATE value and an AD (attitude determination) value. It is up to the user to determine if data outside 1040 is usable. AD values NOT AD_FINE_CONVERGED should be suspect. STATE_HIGH is expected, but STATE_MED is possible during maneuvers.</p>	binary	EPOCH

metadata

Variable Name	Description	Units	Dimensions
ICON Ancillary FUV Turret Flag	Turret Angle Flag Binary flag indicating when the turret angle information is unavailable. 0 is when angle is known, 1 is when the angle is not reported and has been set to zero.	binary	EPOCH

Acknowledgement

This is a data product from the NASA Ionospheric Connection Explorer mission, an Explorer launched on 21:59:45 EDT on October 10, 2019. Guidelines for the use of this product are described in the ICON Rules of the Road (<https://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. Jeffrey Klenzing.

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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