ICON Data Product 2.7: IVM Ionospheric Parameters

This document describes the data product for IVM L2 Thermal Plasma file, which is in NetCDF4 format.

This is the version 8 release of geophysical data for the Ion Velocity Meter (IVM) on-board the Ionospheric Connections Explorer (ICON) satellite. The IVM is comprised of two instruments, the Retarding Potential Analyzer (RPA) and the Drift Meter (DM). The IVM is operating very well and with low noise, generally producing high quality outputs. Data processing challenges involve the transition from low to moderate solar activity for which the O+/H+ ratio in ion composition changes from near 0 to 1. Under such conditions an independent derivation of ram ion drift and aperture potential is not always possible. A model of the aperture potential variation must be utilized when the O+/H+ ratio exceeds 90% and the ram drift cannot be sensibly derived when the O+/H+ ratio is less than 5%. During the local time hours, from 1100 to 2400, all parameters are generally available and high quality. This product contains several data quality flags that should be examined to ensure the highest fidelity data. Good data for all parameters, including ion drifts, may be down-selected by selecting times where two flags, ICON_L27_RPA_FLAG_PROCESS and ICON_L27_DM_FLAG_PROCESS, are both zero or one. Parameters such as ion density and composition are generally always reliable, followed by ion temperature, then the three dimensional ion drift vector. The ion temperature may demonstrate an increased variance in the early morning hours but early analysis indicates the values are otherwise high quality. Unlike the other parameters, determination of the ion drifts requires a minimum absolute O+ density. At night, the absolute O+ densities can fall below the detection limit of the IVM. When this occurs, resolving the ion motion along the IVM look direction can be challenging. During these periods the ion velocity is set to zero with respect to a corotating atmosphere. Use of the full 3D vectors (ICON_L27_Ion_Velocity_Meridional, ICON_L27_Ion_Velocity_Zonal, and ICON_L27_Ion_Velocity_Field_Aligned) during these periods is not recommended (ICON_L27_RPA_FLAG_PROCESS=2). The magnetic meridional ion drift near the magnetic equator, magnetic latitudes +/- 5 degrees, is primarily given by ICON_L27_Ion_Velocity_Z (positive towards Earth), and may be used as an approximation even when the RPA_FLAG_PROCESS=2. The Drift Meter (DM) measures cross-track motions and excludes H+ ions. Low O+ densities, particularly at dawn, make measurements a challenge. A flag is set when O+ densities are too low for the hardware to function (ICON_L27_DM_FLAG_PROCESS=32). The low O+ densities exacerbates the impact of photoemission upon measurements within the DM. Ion drifts that require a significant photoemission correction have been masked (ICON_L27_DM_FLAG_PROCESS=64). Any spacecraft operations that may have the potential to impact the outputs are currently flagged (ICON_L27_RPA_FLAG_PROCESS=8, ICON_L27_DM_FLAG_PROCESS=8). Impacts are likely more prevalent in the DM than RPA, depending upon the operation. See spacecraft flags for more.)
Prior to rotation into magnetic coordinates the ion drift in the spacecraft frame is corrected by applying offsets that produce a geophysically self-consistent dataset. The following conditions are applied in a minimum variance fashion over a satellite precession period to determine the offsets as a function of mission time.
1. The local time average of the meridional (vertical) drift at the magnetic equator is zero
2. The local time average of the zonal (east-west) drift at the magnetic equator should be greater than or equal to zero.
3. The meridional and zonal drifts at conjugate locations (±12°) should be the same.
4. The long term (seasonal) variations in the zonal and field-aligned drifts at the magnetic equator should be the same for northbound and southbound passes.
See Var_notes for offset extraction.

History

Version 001, R. A. Stoneback, 2019-08-06T00:00:00, Initial Release

Version 002, R. A. Stoneback, 2020-06-19T00:00:00, Update for public release, adds quality flags

Version 003, R. A. Stoneback, 2020-04-10T00:00:00, Adds first order photoemission correction

Version 004, R. A. Stoneback, 2020-12-03T00:00:00, Adjustments to IVM offsets

Version 005, R. A. Stoneback, 2021-03-21T00:00:00, Improvements to RPA Fit noise, Drifts in East, North, Up. Data between 0500 and 1200 should be rejected at this time due to poor S/N and contaminant signals from internally generated photocurrents that have not been removed.
The V05 data product has been corrected for long-term systematic offsets produced by uncertainties in the electrostatic environment of the spacecraft. The corrected variables are:
ICON_L27_Ion_Velocity_X
ICON_L27_Ion_Velocity_Y
ICON_L27_Ion_Velocity_Z
They are used to compute the plasma drifts in magnetic coordinates.
The uncorrected data may be accessed directly in the variables
ICON_L27_Raw_Ion_Velocity_X
ICON_L27_Raw_Ion_Velocity_Y
ICON_L27_Raw_Ion_Velocity_Z
Short term variations with periods less than 10 days have not been removed but may be accurately assessed from examination of the zonal (daily) average of the meridional drift ICON_L27_Ion_Velocity_Meridional within 1 hour of 1800 MLT. Zonal averages in excess of 5 m/s over this local time range provide a reliable estimate of the short-term offset.

Version 006, Matthew Depew 2022-03-14, The V06 data product has been improved to handle large O+ fractions and to include cross-track ion drifts derived by neglecting inputs from the RPA.The algorithm used to account for large O+ fractions was changed for data after March 4th 2022. Data products has been corrected for long-term systematic offsets produced by uncertainties in the electrostatic environment of the spacecraft. The corrected variables are: ICON_L27_Ion_Velocity_X, ICON_L27_Ion_Velocity_Y, ICON_L27_Ion_Velocity_Z. They are used to compute the plasma drifts in magnetic coordinates. The uncorrected data may be accessed directly in the variables ICON_L27_Raw_Ion_Velocity_X, ICON_L27_Raw_Ion_Velocity_Y, ICON_L27_Raw_Ion_Velocity_Z Transverse ion drifts derived by neglecting RPA inputs may be accessed directly in the variables ICON_L27_Original_Velocity_Y, ICON_L27_Original_Velocity_Z. Short term variations with periods less than 10 days have not been removed but may be accurately assessed from examination of the zonal (daily) average of the meridional drift ICON_L27_Ion_Velocity_Meridional within 1 hour of 1800 MLT. Zonal averages in excess of 5 m/s over this local time range provide a reliable estimate of the short-term offset.

Version 007, Rod Heelis 2023-05-01, The V07 data product has been refined to more accurately determine ion drift offsets for vertical drifts
Version 008, Rod Heelis 2024-12-20 The V08 data product has been refined to refine ion drift offsets for drifts in instrument frame and to include estimated uncertainties for all derived geophysical quantities.

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	unlimited

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
`Epoch`	Universal Time (UTC) Time at the midpoint of the IVM measurements.	Milliseconds since 1970-01-01 00:00:00	`Epoch`
`ICON_L27_Altitude`	WGS84 Altitude of Spacecraft Position (geodetic) Geodetic Altitude of Spacecraft in WGS84.	km	`Epoch`
`ICON_L27_Fractional_Ion_Density_H`	Fraction of total plasma number density that is H+ Determined via a non-linear least squares fit of RPA currents to the Whipple equation		`Epoch`
`ICON_L27_Fractional_Ion_Density_O`	Fraction of total plasma number density that is O+ Determined via a non-linear least squares fit of RPA currents to the Whipple equation		`Epoch`
`ICON_L27_Latitude`	WGS84 Latitude of Spacecraft Position (geodetic) Geodetic latitude of spacecraft in WGS84	degrees North	`Epoch`
`ICON_L27_Solar_Local_Time`	Local Solar Time at Spacecraft Local Solar Time at spacecraft.	hour	`Epoch`
`ICON_L27_Magnetic_Local_Time`	Magnetic Local Time at Spacecraft Magnetic Local Time at the spacecraft.	hour	`Epoch`
`ICON_L27_Longitude`	WGS84 Longitude of Spacecraft Position (geodetic) Geodetic longitude of spacecraft in WGS84	degrees East	`Epoch`
`ICON_L27_Ion_Density`	Ion density determined using RPA measurements. Ion density uses measured currents and co-rotating atmosphere to determine density.	N/cc	`Epoch`
`ICON_L27_Ion_Temperature`	Ion temperature determined using a best fit of RPA measurements to Whipple equation. Temperature is obtained by assuming single temperature value for all plasma.	K	`Epoch`

Variable Name	Description	Units	Dimensions
ICON_L27_Ion_Velocity_Field_Aligned	Ion Velocity Field Aligned Ion velocity relative to co-rotation along geomagnetic field lines. Positive along the main field vector. Velocity obtained using ion velocities relative to co-rotation in the instrument frame along with the corresponding unit vectors expressed in the instrument frame to derive the observed ion drift along the geomagnetic field.	m/s	Epoch
ICON_L27_Ion_Velocity_Meridional	Ion Velocity Meridional Ion velocity along local magnetic meridional direction, perpendicular to geomagnetic field and within local magnetic meridional plane. The local meridional vector maps to vertical at the magnetic equator, positive is up. Velocity obtained using ion velocities relative to co-rotation in the instrument frame along with the corresponding unit vectors expressed in the instrument frame to derive the observed ion drift along the geomagnetic meridional direction	m/s	Epoch
ICON_L27_Ion_Velocity_X	IVM Ion Velocity X In-track velocity is relative to co-rotation and in the instrument frame. Positive-x is normal to IVM aperture plane and in the direction of satellite motion. Velocity obtained through fitting of RPA currents to the Whipple equation to get a measure of the total along track ion velocity as observed within the instrument. Signals produced by the motion of the spacecraft and the rotation of the Earth are removed to produce this result. Mean offset removed and determined by requirement for local time average zonal drift to be zero, while n/b and s/b crossings agree and magnetic conjugacy is approximately achieved. Offset given by -ICON_L27_Raw_Ion_Velocity_X - ICON_L27_Observatory_Corotation_X + ICON_L27_Observatory_Velocity_X - ICON_L27_Ion_Velocity_X	m/s	Epoch
ICON_L27_Ion_Velocity_Y	IVM Ion Velocity Y Cross-track velocity is relative to co-rotation and in the instrument frame. Positive-y points generally southward when the instrument is pointed along the ram direction. Velocity obtained through conversion of arrival angles measured by the DM into a cross track velocity using trigonometry. Signals produced by the motion of the spacecraft and the rotation of the Earth are removed to produce this result. Mean offset removed and determined by requirement for local time average zonal drift to be zero, while n/b and s/b crossings agree and magnetic conjugacy is approximately achieved. Offset given by ICON_L27_Raw_Ion_Velocity_Y - ICON_L27_Observatory_Corotation_Y + ICON_L27_Observatory_Velocity_Y - ICON_L27_Ion_Velocity_Y	m/s	Epoch

Variable Name	Description	Units	Dimensions
ICON_L27_Ion_Velocity_Z	IVM Ion Velocity Z Cross-track velocity is relative to co-rotation and in the instrument frame. Positive-z is directed towards nadir (Earth). Velocity obtained through conversion of arrival angles measured by the DM into a cross track velocity using trigonometry. Signals produced by the motion of the spacecraft and the rotation of the Earth are removed to produce this result. Mean offset removed and determined by requirement for local time average zonal drift to be zero, while n/b and s/b crossings agree and magnetic conjugacy is approximately achieved. Offset given by ICON_L27_Raw_Ion_Velocity_Z - ICON_L27_Observatory_Corotation_Z + ICON_L27_Observatory_Velocity_Z - ICON_L27_Ion_Velocity_Z	m/s	Epoch
ICON_L27_Ion_Velocity_Zonal	Ion Velocity Zonal Ion velocity relative to co-rotation along the magnetic zonal direction, normal to local magnetic meridional plane and the geomagnetic field (positive east). The local zonal vector maps to purely horizontal at the magnetic equator. Velocity obtained using ion velocities relative to co-rotation in the instrument frame along with the corresponding unit vectors expressed in the instrument frame to derive the observed ion drift along a geomagnetic zonal direction.	m/s	Epoch
ICON_L27_Raw_Ion_Velocity_X	Raw ion velocity determined using a best fit of RPA measurements to the Whipple equation. This is the total ion velocity along normal direction into the RPA, including s/c motion.	m/s	Epoch
ICON_L27_Raw_Ion_Velocity_Y	Total ion velocity measured along IVM-y. Total observed ion velocity along instrument cross-track direction, reported in the instrument frame. The translation of DM measured angles to ion velocities uses knowledge of the ram velocity of the plasma and the electric potential of the instrument aperture relative to the ambient plasma, both of which are provided by the RPA.	m/s	Epoch
ICON_L27_Raw_Ion_Velocity_Z	Total ion velocity measured along IVM-z. Total observed ion velocity along instrument cross-track direction, reported in the instrument frame. The translation of DM measured angles to ion velocities uses knowledge of the ram velocity of the plasma and the electric potential of the instrument aperture relative to the ambient plasma, both of which are provided by the RPA.	m/s	Epoch
ICON_L27_Original_Ion_Velocity_Y	Original Ion Velocity Y Total observed ion velocity along instrument cross-track direction, reported in the instrument frame. The translation of DM measured angles to ion velocities using the s/c ram velocity only.	m/s	Epoch
ICON_L27_Original_Ion_Velocity_Z	Original Ion Velocity Z Total observed ion velocity along instrument cross-track direction, reported in the instrument frame. The translation of DM measured angles to ion velocities using the s/c ram velocity only.	m/s	Epoch

Variable Name	Description	Units	Dimensions
ICON_L27_Unit_Vector_Meridional_X	Unit vector for the geomagnetic meridional direction. The meridional unit vector is perpendicular to the geomagnetic field and maps along magnetic field lines to vertical at the magnetic equator, where positive is up. The unit vector is expressed here in the IVM coordinate system, where x is along the IVM boresight, nominally along ram when in standard pointing. Calculated using the corresponding unit vector in ECEF and the orientation of the IVM also expressed in ECEF (sc_*hat_*).		Epoch
ICON_L27_Unit_Vector_Meridional_Y	Unit vector for the geomagnetic meridional direction. The meridional unit vector is perpendicular to the geomagnetic field and maps along magnetic field lines to vertical at the magnetic equator, where positive is up. The unit vector is expressed here in the IVM coordinate system, where Y = Z x X, nominally southward when in standard pointing, X along ram. Calculated using the corresponding unit vector in ECEF and the orientation of the IVM also expressed in ECEF (sc_*hat_*).		Epoch
ICON_L27_Unit_Vector_Meridional_Z	Unit vector for the geomagnetic meridional direction. The meridional unit vector is perpendicular to the geomagnetic field and maps along magnetic field lines to vertical at the magnetic equator, where positive is up. The unit vector is expressed here in the IVM coordinate system, where Z is nadir pointing (towards Earth), when in standard pointing, X along ram. Calculated using the corresponding unit vector in ECEF and the orientation of the IVM also expressed in ECEF (sc_*hat_*).		Epoch
ICON_L27_IVM_Aperture_Potential	Plasma potential relative to instrument aperture plane - determined using a best fit to RPA measurements. Incident plasma will have some potential to the IVM aperture plane. The aperture plane voltage matches that of a conductor allowed to float electrically with respect to the spacecraft. The flux of ions (driven by s/c motion) must be balanced by the flux of electrons (driven by electron temperature). The value of the aperture plane potential evolves naturally to limit the collection of electrons such the net flux is zero.	V	Epoch
ICON_L27_Unit_Vector_Field_Aligned_X	Unit vector for the geomagnetic field line direction. The field-aligned vector points along the geomagnetic field, with positive values along the field direction, and is expressed here in the IVM instrument frame. The IVM-x direction points along the instrument boresight, which is pointed into ram for standard operations.Calculated using the corresponding unit vector in ECEF and the orientation of the IVM also expressed in ECEF (sc_*hat_*).		Epoch
ICON_L27_Unit_Vector_Field_Aligned_Y	Unit vector for the geomagnetic field line direction. The field-aligned vector points along the geomagnetic field, with positive values along the field direction. The unit vector is expressed here in the IVM coordinate system, where Y = Z x X, nominally southward when in standard pointing, X along ram. Calculated using the corresponding unit vector in ECEF and the orientation of the IVM also expressed in ECEF (sc_*hat_*).		Epoch

Variable Name	Description	Units	Dimensions
ICON_L27_Unit_Vector_Field_Aligned_Z	Unit vector for the geomagnetic field line direction. The field-aligned vector points along the geomagnetic field, with positive values along the field direction, and is expressed here in the IVM instrument frame. The IVM-Z direction points towards nadir when IVM-X is pointed into ram for standard operations.Calculated using the corresponding unit vector in ECEF and the orientation of the IVM also expressed in ECEF (sc_*hat_*).		Epoch
ICON_L27_Unit_Vector_Zonal_X	Unit vector for the zonal geomagnetic direction. The zonal vector is perpendicular to the local magnetic field and the magnetic meridional plane. The zonal vector maps to purely horizontal at the magnetic equator, with positive values pointed generally eastward. This vector is expressed here in the IVM instrument frame.The IVM-x direction points along the instrument boresight, which is pointed into ram for standard operations.Calculated using the corresponding unit vector in ECEF and the orientation of the IVM also expressed in ECEF (sc_*hat_*).		Epoch
ICON_L27_Unit_Vector_Zonal_Y	Unit vector for the zonal geomagnetic direction. The zonal vector is perpendicular to the local magnetic field and the magnetic meridional plane. The zonal vector maps to purely horizontal at the magnetic equator, with positive values pointed generally eastward. The unit vector is expressed here in the IVM coordinate system, where Y = Z x X, nominally southward when in standard pointing, X along ram. Calculated using the corresponding unit vector in ECEF and the orientation of the IVM also expressed in ECEF (sc_*hat_*).		Epoch
ICON_L27_Unit_Vector_Zonal_Z	Unit vector for the zonal geomagnetic direction. The zonal vector is perpendicular to the local magnetic field and the magnetic meridional plane. The zonal vector maps to purely horizontal at the magnetic equator, with positive values pointed generally eastward. This vector is expressed here in the IVM instrument frame.The IVM-Z direction points towards nadir when IVM-X is pointed into ram for standard operations.Calculated using the corresponding unit vector in ECEF and the orientation of the IVM also expressed in ECEF (sc_*hat_*).		Epoch
ICON_L27_MTB_Status	Magnetic Torquer Bar Firing Status If the magnetic torquers are active during any part of the measurement, it is recorded as active for whole measurement. Decoded from spacecraft housekeeping file: ICON_L0_Spacecraft_Housekeeping-MTB_2019-11-19_v01r004.CSV	binary	Epoch
ICON_L27_Slew_Status			Epoch
ICON_L27_Sun_Status	Spacecraft Sun/Shadow Status Code Data is from predictive ephemeris. 0 = spacecraft in Sun, 1 = spacecraft in Earth Shadow.	binary	Epoch

Variable Name	Description	Units	Dimensions
ICON_L27_Space_Environment_Region_Status	Space Environment Region Status Standarized for several missions, not all codes are relevant for ICON where 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_L27_Attitude_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_L27_Orbit_Number	Orbit Number Integer Orbit Number.	integer	Epoch

Variable Name	Description	Units	Dimensions
ICON_L27_Magnetic_Latitude	Magnetic Latitude of Spacecraft Position Quasi-dipole magnetic latitude of the spacecraft position. These values are obtained from passing the geodectic latitudes, longitudes, and altitudes from ICON_ANCILLARY_IVM_LATITUDE, ICON_ANCILLARY_IVM_LONGITUDE, and ICON_ANCILLARY_IVM_ALTITUDE into apexpy Python module. For details on apexpy see: https://apexpy.readthedocs.org/	degrees North	Epoch
ICON_L27_Magnetic_Longitude	Magnetic Longitude of Spacecraft Position Quasi-dipole magnetic longitude of the spacecraft position. These values are obtained from passing the geodectic latitudes, longitudes, and altitudes from ICON_ANCILLARY_IVM_LATITUDE, ICON_ANCILLARY_IVM_LONGITUDE, and ICON_ANCILLARY_IVM_ALTITUDE into apexpy Python module. For details on apexpy see: https://apexpy.readthedocs.org/	degrees East	Epoch
ICON_L27_DM_Flag_Process	Drift meter quality flag. This flag applies to the following variables: ICON_L27_Raw_Ion_Velocity_Y, ICON_L27_Raw_Ion_Velocity_Z, ICON_L27_Original_Ion_Velocity_Y, ICON_L27_Original_Ion_Velocity_Z, ICON_L27_Ion_Velocity_Y, ICON_L27_Ion_Velocity_Z, ICON_L27_Ion_Velocity_Meridional, ICON_L27_Ion_Velocity_Zonal, ICON_L27_Ion_Velocity_Field_Aligned, ICON_L27_Ion_Velocity_East, ICON_L27_Ion_Velocity_North, ICON_L27_Ion_Velocity_Up, ICON_L27_Footpoint_Meridional_Ion_Velocity_North, ICON_L27_Footpoint_Meridional_Ion_Velocity_South, ICON_L27_Footpoint_Zonal_Ion_Velocity_North, ICON_L27_Footpoint_Zonal_Ion_Velocity_South, ICON_L27_Footpoint_Up_Ion_Velocity_North, ICON_L27_Footpoint_Up_Ion_Velocity_South, Values represent bits of the flag, multiple of which may be set at a time. This flag is less than or equal to 1 when the data is of highest quality. Vx and magnetic component drifts should be rejected when this flag is greater than 0. 0 - Good data. 1 - Drift components utilize model for ram drift. 2 - Data possibly degraded by signal noise. 4 - Data probably degraded by signal noise. 8 - Data may have artifacts due to s/c operations. 16 - Spacecraft attitude may significantly impact performance. 32 - Not enough O+ to measure arrival angle. 64 - Data temporarily removed for photoemission. e.g. DM_Flag=9 Velocity obtained using ram drift model during torquer rod firing		Epoch

Variable Name	Description	Units	Dimensions
ICON_L27_RPA_Flag_Process	RPA Quality Flag Status flag for RPA. This flag applies to the following variables: ICON_L27_Raw_Ion_Velocity_X, ICON_L27_IVM_Aperture_Potential, ICON_L27_Ion_Velocity_X, ICON_L27_Ion_Temperature, ICON_L27_Fractional_Ion_Density_O, ICON_L27_Fractional_Ion_Density_H, ICON_L27_Ion_Velocity_Meridional, ICON_L27_Ion_Velocity_Zonal, ICON_L27_Ion_Velocity_Field_Aligned, ICON_L27_Ion_Velocity_East, ICON_L27_Ion_Velocity_North, ICON_L27_Ion_Velocity_Up, ICON_L27_Footpoint_Meridional_Ion_Velocity_North, ICON_L27_Footpoint_Meridional_Ion_Velocity_South, ICON_L27_Footpoint_Zonal_Ion_Velocity_North, ICON_L27_Footpoint_Zonal_Ion_Velocity_South, ICON_L27_Footpoint_Up_Ion_Velocity_North, ICON_L27_Footpoint_Up_Ion_Velocity_South, Values represent bits of the flag, multiple of which may be set at a time. This flag is less than 1 when the data is of highest quality. When the flag is 2, data should be used with caution as it is partially derived from a model. Data when the flag is greater than 2 should be rejected 0 - All RPA parameters are good. Ion temperatures correspond to both O+ and H+. 1 - Ram Ion Velocities are computed with aperture potential model. Other parameters unchanged. 2 - Model values for ram drift use when fitting RPA curves that have an insufficient quantity of O+. Ion temperatures correspond to H+ only. 4 - Unsuccessful fit to RPA. 8 - Geophysical outputs may be impacted by spacecraft operations. 16 - Geophysical outputs may be significantly impacted by spacecraft attitude. e.g. RPA_Flag=9 Velocity obtained using aperture potential model during torquer rod firing		Epoch
ICON_L27_DM_Flag	Drift meter quality flag. This flag applies to the following variables: ICON_L27_Raw_Ion_Velocity_Y, ICON_L27_Raw_Ion_Velocity_Z, ICON_L27_Original_Ion_Velocity_Y, ICON_L27_Original_Ion_Velocity_Z, ICON_L27_Ion_Velocity_Y, ICON_L27_Ion_Velocity_Z, ICON_L27_Ion_Velocity_Meridional, ICON_L27_Ion_Velocity_Zonal, ICON_L27_Ion_Velocity_Field_Aligned, ICON_L27_Ion_Velocity_East, ICON_L27_Ion_Velocity_North, ICON_L27_Ion_Velocity_Up, ICON_L27_Footpoint_Meridional_Ion_Velocity_North, ICON_L27_Footpoint_Meridional_Ion_Velocity_South, ICON_L27_Footpoint_Zonal_Ion_Velocity_North, ICON_L27_Footpoint_Zonal_Ion_Velocity_South, ICON_L27_Footpoint_Up_Ion_Velocity_North, ICON_L27_Footpoint_Up_Ion_Velocity_South, 0 - Good data. 1 - Use with caution. 2 - Corrected with Photoemission model. 3 - Should be rejected.		Epoch

Variable Name	Description	Units	Dimensions
ICON_L27_RPA_Flag	RPA Quality Flag Quality flag for RPA. This flag applies to the following variables: ICON_L27_Raw_Ion_Velocity_X, ICON_L27_IVM_Aperture_Potential, ICON_L27_Ion_Velocity_X, ICON_L27_Ion_Temperature, ICON_L27_Fractional_Ion_Density_O, ICON_L27_Fractional_Ion_Density_H, ICON_L27_Ion_Velocity_Meridional, ICON_L27_Ion_Velocity_Zonal, ICON_L27_Ion_Velocity_Field_Aligned, ICON_L27_Ion_Velocity_East, ICON_L27_Ion_Velocity_North, ICON_L27_Ion_Velocity_Up, ICON_L27_Footpoint_Meridional_Ion_Velocity_North, ICON_L27_Footpoint_Meridional_Ion_Velocity_South, ICON_L27_Footpoint_Zonal_Ion_Velocity_North, ICON_L27_Footpoint_Zonal_Ion_Velocity_South, ICON_L27_Footpoint_Up_Ion_Velocity_North, ICON_L27_Footpoint_Up_Ion_Velocity_South, 0 - Good data. 1 - Use with caution. 2 - Should be rejected.		Epoch
ICON_L27_UTC_Time	ISO 9601 formatted UTC timestamp (at middle of reading). ISO 9601 formatted UTC timestamp (at middle of reading). Time is generated from the time-code at byte 1015 of the IVM packet minus the time sync at byte 1019 of the IVM packet. This is the GPS time at the start of the integration period. The integration period is assumed to be 4 seconds so the center time is 2 seconds after that. The formula is (time-code * 1000ms) + 2000ms - (16 * time sync / 1000) in GPS milliseconds then converted to UTC time. See the UTD 206-024 Rev A document. Time may be delayed by up to 10 ms due to FSW polling delay. Maximum time is ~2150 UTC and minimum time is ~1970 UTC.		Epoch
ICON_L27_Time_UTC_Start	Milliseconds since 1970-01-01 00:00:00 UTC at start of reading. Milliseconds since 1970-01-01 00:00:00 UTC at start of reading. Time is generated from the time-code at byte 1015 of the IVM packet minus the time sync at byte 1019 of the IVM packet. This is the GPS time at the start of the integration period. The integration period is assumed to be 4 seconds so the center time is 2 seconds after that. The formula is (time-code * 1000ms) + 2000ms - (16 * time sync / 1000) in GPS milliseconds then converted to UTC time. See the UTD 206-024 Rev A document. Time may be delayed by up to 10 ms due to FSW polling delay. Maximum time is ~2150 UTC and minimum time is ~1970 UTC.	milliseconds	Epoch

Variable Name	Description	Units	Dimensions
ICON_L27_Time_UTC_Stop	Milliseconds since 1970-01-01 00:00:00 UTC at end of reading. Milliseconds since 1970-01-01 00:00:00 UTC at end of reading. Time is generated from the time-code at byte 1015 of the IVM packet minus the time sync at byte 1019 of the IVM packet. This is the GPS time at the start of the integration period. The integration period is assumed to be 4 seconds so the center time is 2 seconds after that. The formula is (time-code * 1000ms) + 2000ms - (16 * time sync / 1000) in GPS milliseconds then converted to UTC time. See the UTD 206-024 Rev A document. Time may be delayed by up to 10 ms due to FSW polling delay. Maximum time is ~2150 UTC and minimum time is ~1970 UTC.	milliseconds	Epoch
ICON_L27_Apex_Height	Modified APEX Height Modified APEX height of the spacecraft position.	km	Epoch
ICON_L27_GPS_Epoch	Milliseconds since 1980-01-06 00:00:00 TAI (coincident with UTC) at middle of reading. Milliseconds since 1980-01-06 00:00:00 TAI (coincident with UTC) at middle of reading. Time is generated from the time-code at byte 1015 of the IVM packet minus the time sync at byte 1019 of the IVM packet. This is the GPS time at the start of the integration period. The integration period is assumed to be 4 seconds so the center time is 2 seconds after that. The formula is (time-code * 1000ms) + 2000ms - (16 * time sync / 1000) in GPS milliseconds then converted to UTC time. See the UTD 206-024 Rev A document. Time may be delayed by up to 10 ms due to FSW polling delay. Maximum time is ~2150 UTC and minimum time is ~1970 UTC.	milliseconds	Epoch

Variable Name	Description	Units	Dimensions
`ICON_L27_A_Status`	IVM-A Status Binary Coded Integer where 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 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.	binary	`Epoch`
`ICON_L27_B_Status`	IVM-B Status Binary Coded Integer where 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 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.	binary	`Epoch`

Variable Name	Description	Units	Dimensions
ICON_L27_A_Activity	IVM-A Activity Binary Coded Integer where: 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 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.	binary	Epoch
ICON_L27_B_Activity	IVM-A Activity Binary Coded Integer where: 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 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.	binary	Epoch
ICON_L27_Footpoint_Altitude_North	Altitude of North Footpoint of Geomagnetic Line at 150 km from IGRF Altitude location of the magnetic footpoint in the Northern Hemisphere at 150 km. These data were interpolated using a tricubic algorithm from IGRF and ephemeris data then linearly interploted to IVM times.	km	Epoch
ICON_L27_Footpoint_Field_Aligned_Vector_ECEF_X_North	ECEF X-Component of Field Aligned Drift Direction at Northern Footpoint At the northern footpoint this is the x-component of the unit vector for field aligned ion drifts expressed in the ECEF frame.	dimensionless	Epoch

Variable Name	Description	Units	Dimensions
ICON_L27_Footpoint_Field_Aligned_Vector_ECEF_Y_North	ECEF Y-Component of Field Aligned Drift Direction at Northern Footpoint At the northern footpoint this is the y-component of the unit vector for field aligned ion drifts expressed in the ECEF frame.	dimensionless	Epoch
ICON_L27_Footpoint_Field_Aligned_Vector_ECEF_Z_North	ECEF Z-Component of Field Aligned Drift Direction at Northern Footpoint At the northern footpoint this is the z-component of the unit vector for field aligned ion drifts expressed in the ECEF frame.	dimensionless	Epoch
ICON_L27_Footpoint_Latitude_North	Latitude of North Footpoint of Geomagnetic Line at 150 km from IGRF Latitude location of the magnetic footpoint in the Northern Hemisphere at 150 km. These data were interpolated using a tricubic algorithm from IGRF and ephemeris data then linearly interploted to IVM times.	degrees	Epoch
ICON_L27_Footpoint_Longitude_North	Longitude of North Footpoint of Geomagnetic Line at 150 km from IGRF Longitude location of the magnetic footpoint in the Northern Hemisphere at 150 km. These data were interpolated using a tricubic algorithm from IGRF and ephemeris data then linearly interploted to IVM times.	degrees	Epoch
ICON_L27_Footpoint_Meridional_Ion_Velocity_North	Northern Meridional Ion Velocity Velocity along local magnetic meridional direction, perpendicular to geomagnetic field and within local magnetic meridional plane, field-line mapped to northern footpoint. The meridional vector is purely vertical at the magnetic equator, positive up. Velocity obtained using ion velocities relative to co-rotation in the instrument frame along with the corresponding unit vectors expressed in the instrument frame. Field-line mapping and the assumption of equi-potential field lines is used to translate the locally measured ion motion to the magnetic footpoint. The mapping is used to determine the change in magnetic field line distance, which, under assumption of equipotential field lines, in turn alters the electric field at that location (E=V/d).	m/s	Epoch
ICON_L27_Footpoint_Magnetic_Latitude_North	Quasi-dipole Latitude of Northern Footpoint Calculated value of quasi-dipole latitude of northern footpoint from IGRF.	degrees	Epoch
ICON_L27_Footpoint_Magnetic_Longitude_North	Quasi-dipole Longitude of Northern Footpoint Calculated value of quasi-dipole longitude of northern footpoint from IGRF	degrees	Epoch
ICON_L27_Footpoint_Meridional_Vector_ECEF_X_North	ECEF X-Component of Meridional Drift Direction at Northern Footpoint At the northern footpoint this is the x-component of the unit vector for meridional ion drifts expressed in the ECEF frame.	dimensionless	Epoch

Variable Name	Description	Units	Dimensions
ICON_L27_Footpoint_Meridional_Vector_ECEF_Y_North	ECEF Y-Component of Meridional Drift Direction at Northern Footpoint At the northern footpoint this is the y-component of the unit vector for meridional ion drifts expressed in the ECEF frame.	dimensionless	Epoch
ICON_L27_Footpoint_Meridional_Vector_ECEF_Z_North	ECEF Z-Component of Meridional Drift Direction at Northern Footpoint At the northern footpoint this is the z-component of the unit vector for meridional ion drifts expressed in the ECEF frame.	dimensionless	Epoch
ICON_L27_Footpoint_Zonal_Ion_Velocity_North	Northern Zonal Ion Velocity Velocity along local magnetic zonal direction, perpendicular to geomagnetic field and the local magnetic meridional plane, field-line mapped to northern footpoint. The zonal vector is purely horizontal when mapped to the magnetic equator, positive is generally eastward. Velocity obtained using ion velocities relative to co-rotation in the instrument frame along with the corresponding unit vectors expressed in the instrument frame. Field-line mapping and the assumption of equi-potential field lines is used to translate the locally measured ion motion to the northern footpoint. The mapping is used to determine the change in magnetic field line distance, which, under assumption of equipotential field lines, in turn alters the electric field at that location (E=V/d).	m/s	Epoch
ICON_L27_Footpoint_Zonal_Vector_ECEF_X_North	ECEF X-Component of Zonal Drift Directrion at Northern Footpoint At the northern footpoint this is the x-component of the unit vector for zonal ion drifts expressed in the ECEF frame.	dimensionless	Epoch
ICON_L27_Footpoint_Zonal_Vector_ECEF_Y_North	ECEF Y-Component of Zonal Drift Directrion at Northern Footpoint At the northern footpoint this is the y-component of the unit vector for zonal ion drifts expressed in the ECEF frame.	dimensionless	Epoch
ICON_L27_Footpoint_Zonal_Vector_ECEF_Z_North	ECEF Z-Component of Zonal Drift Direction at Northern Footpoint At the northern footpoint this is the z-component of the unit vector for zonal ion drifts expressed in the ECEF frame.	dimensionless	Epoch
ICON_L27_Footpoint_Altitude_South	Altitude of South Footpoint of Geomagnetic Line at 150 km from IGRF Altitude location of the magnetic footpoint in the Northern Hemisphere at 150 km. These data were interpolated using a tricubic algorithm from IGRF and ephemeris data then linearly interploted to IVM times.	km	Epoch
ICON_L27_Footpoint_Field_Aligned_Vector_ECEF_X_South	ECEF X-Component of Field Aligned Drift Direction at Southern Footpoint At the Southern footpoint this is the x-component of the unit vector for field aligned ion drifts expressed in the ECEF frame.	dimensionless	Epoch

Variable Name	Description	Units	Dimensions
ICON_L27_Footpoint_Field_Aligned_Vector_ECEF_Y_South	ECEF Y-Component of Field Aligned Drift Direction at Southern Footpoint At the Southern footpoint this is the y-component of the unit vector for field aligned ion drifts expressed in the ECEF frame.	dimensionless	Epoch
ICON_L27_Footpoint_Field_Aligned_Vector_ECEF_Z_South	ECEF Z-Component of Field Aligned Drift Direction at Southern Footpoint At the Southern footpoint this is the z-component of the unit vector for field aligned ion drifts expressed in the ECEF frame.	dimensionless	Epoch
ICON_L27_Footpoint_Latitude_South	Latitude of South Footpoint of Geomagnetic Line at 150 km from IGRF Latitude location of the magnetic footpoint in the Southern Hemisphere at 150 km. These data were interpolated using a tricubic algorithm from IGRF and ephemeris data then linearly interploted to IVM times.	degrees	Epoch
ICON_L27_Footpoint_Longitude_South	Longitude of South Footpoint of Geomagnetic Line at 150 km from IGRF Longitude location of the magnetic footpoint in the Southern Hemisphere at 150 km. These data were interpolated using a tricubic algorithm from IGRF and ephemeris data then linearly interploted to IVM times.	degrees	Epoch
ICON_L27_Footpoint_Meridional_Ion_Velocity_South	Southern Meridional Ion Velocity Velocity along local magnetic meridional direction, perpendicular to geomagnetic field and within local magnetic meridional plane, field-line mapped to southern footpoint. The meridional vector is purely vertical at the magnetic equator, positive up. Velocity obtained using ion velocities relative to co-rotation in the instrument frame along with the corresponding unit vectors expressed in the instrument frame. Field-line mapping and the assumption of equi-potential field lines is used to translate the locally measured ion motion to the magnetic footpoint. The mapping is used to determine the change in magnetic field line distance, which, under assumption of equipotential field lines, in turn alters the electric field at that location (E=V/d).	m/s	Epoch
ICON_L27_Footpoint_Magnetic_Latitude_South	Quasi-dipole Latitude of Southern Footpoint Calculated value of quasi-dipole latitude of southern footpoint from IGRF	degrees	Epoch
ICON_L27_Footpoint_Magnetic_Longitude_South	Quasi-dipole Longitude of Southern Footpoint Calculated value of quasi-dipole longitude of southern footpoint from IGRF	degrees	Epoch
ICON_L27_Footpoint_Meridional_Vector_ECEF_X_South	ECEF X-Component of Meridional Drift Direction at Southern Footpoint At the Southern footpoint this is the x-component of the unit vector for meridional ion drifts expressed in the ECEF frame.	dimensionless	Epoch

Variable Name	Description	Units	Dimensions
ICON_L27_Footpoint_Meridional_Vector_ECEF_Y_South	ECEF Y-Component of Meridional Drift Direction at Southern Footpoint At the Southern footpoint this is the y-component of the unit vector for meridional ion drifts expressed in the ECEF frame.	dimensionless	Epoch
ICON_L27_Footpoint_Meridional_Vector_ECEF_Z_South	ECEF Z-Component of Meridional Drift Direction at Southern Footpoint At the Southern footpoint this is the z-component of the unit vector for meridional ion drifts expressed in the ECEF frame.	dimensionless	Epoch
ICON_L27_Footpoint_Zonal_Ion_Velocity_South	Southern Zonal Ion Velocity Velocity along local magnetic zonal direction, perpendicular to geomagnetic field and the local magnetic meridional plane, field-line mapped to southern footpoint. The zonal vector is purely horizontal when mapped to the magnetic equator, positive is generally eastward. Velocity obtained using ion velocities relative to co-rotation in the instrument frame along with the corresponding unit vectors expressed in the instrument frame. Field-line mapping and the assumption of equi-potential field lines is used to translate the locally measured ion motion to the southern footpoint. The mapping is used to determine the change in magnetic field line distance, which, under assumption of equipotential field lines, in turn alters the electric field at that location (E=V/d).	m/s	Epoch
ICON_L27_Footpoint_Zonal_Vector_ECEF_X_South	ECEF X-Component of Zonal Drift Direction at Southern Footpoint At the Southern footpoint this is the x-component of the unit vector for zonal ion drifts expressed in the ECEF frame.	dimensionless	Epoch
ICON_L27_Footpoint_Zonal_Vector_ECEF_Y_South	ECEF Y-Component of Zonal Drift Direction at Southern Footpoint At the Southern footpoint this is the y-component of the unit vector for zonal ion drifts expressed in the ECEF frame.	dimensionless	Epoch
ICON_L27_Footpoint_Zonal_Vector_ECEF_Z_South	ECEF Z-Component of Zonal Drift Direction at Southern Footpoint At the Southern footpoint this is the z-component of the unit vector for zonal ion drifts expressed in the ECEF frame.	dimensionless	Epoch
ICON_L27_Observatory_Magnetic_Field_X	X Component of the Magnetic Field at the Spacecraft X-component of the magnetic field from IGRF at the spacecarft position, expressed in the ECEF frame.	nT	Epoch
ICON_L27_Observatory_Magnetic_Field_Y	Y Component of the Magnetic Field at the Spacecraft Y-component of the magnetic field from IGRF at the spacecarft position, expressed in the ECEF frame.	nT	Epoch
ICON_L27_Observatory_Magnetic_Field_Z	Z Component of the Magnetic Field at the Spacecraft Z-component of the magnetic field from IGRF at the spacecarft position, expressed in the ECEF frame.	nT	Epoch

Variable Name	Description	Units	Dimensions
ICON_L27_Equator_Ion_Velocity_Meridional	Equatorial Meridional Ion Velocity Velocity along local magnetic meridional direction, perpendicular to geomagnetic field and within local magnetic meridional plane, field-line mapped to apex/magnetic equator. The meridional vector is purely vertical at the magnetic equator, positive up. Velocity obtained using ion velocities relative to co-rotation in the instrument frame along with the corresponding unit vectors expressed in the instrument frame. Field-line mapping and the assumption of equi-potential field lines is used to translate the locally measured ion motion to the magnetic equator. The mapping is used to determine the change in magnetic field line distance, which, under assumption of equipotential field lines, in turn alters the electric field at that location (E=V/d).	m/s	Epoch
ICON_L27_Equator_Ion_Velocity_Zonal	Equatorial Zonal Ion Velocity Velocity along local magnetic zonal direction, perpendicular to geomagnetic field and the local magnetic meridional plane, field-line mapped to apex/magnetic equator. The zonal vector is purely horizontal when mapped to the magnetic equator, positive is generally eastward. Velocity obtained using ion velocities relative to co-rotation in the instrument frame along with the corresponding unit vectors expressed in the instrument frame. Field-line mapping and the assumption of equi-potential field lines is used to translate the locally measured ion motion to the magnetic equator. The mapping is used to determine the change in magnetic field line distance, which, under assumption of equipotential field lines, in turn alters the electric field at that location (E=V/d).	m/s	Epoch
ICON_L27_Observatory_Velocity_X	ECI Spacecraft Velocity Velocity of spacecraft in ECI, J2000, cooridinates.	m/s	Epoch
ICON_L27_Observatory_Velocity_Y	ECI Spacecraft Velocity Velocity of spacecraft in ECI, J2000, cooridinates.	m/s	Epoch
ICON_L27_Observatory_Velocity_Z	ECI Spacecraft Velocity Velocity of spacecraft in ECI, J2000, cooridinates.	m/s	Epoch
ICON_L27_Observatory_Corotation_X	ECI Earth Corotation Velocity Components in IVM Coordinates Component of Earth's corotation velocity vector projected into the IVM instrument axes by taking the dot product of the corotation vector with the instrument's axes and multiplying the Y and Z components by negative 1 (but not the X component by convention).	m/s	Epoch
ICON_L27_Observatory_Corotation_Y	ECI Earth Corotation Velocity Components in IVM Coordinates Component of Earth's corotation velocity vector projected into the IVM instrument axes by taking the dot product of the corotation vector with the instrument's axes and multiplying the Y and Z components by negative 1 (but not the X component by convention).	m/s	Epoch

Variable Name	Description	Units	Dimensions
ICON_L27_Observatory_Corotation_Z	ECI Earth Corotation Velocity Components in IVM Coordinates Component of Earth's corotation velocity vector projected into the IVM instrument axes by taking the dot product of the corotation vector with the instrument's axes and multiplying the Y and Z components by negative 1 (but not the X component by convention).	m/s	Epoch
ICON_L27_Solar_Zenith_Angle	Solar Zenith Angle at Spacecraft Solar Zenith Angle at the spacecraft.	degrees	Epoch
ICON_L27_Ion_Velocity_East	Ion Velocity East Corrected Ion Drift resolved along the direction parallel to the geodetic latitude zero circle	m/s	Epoch
ICON_L27_Ion_Velocity_North	Ion Velocity North Corrected Ion Drift resolved along the direction parallel to the geodetic longitude zero circle	m/s	Epoch
ICON_L27_Ion_Velocity_Up	Ion Velocity Up Corrected Ion Drift Resolved along the line perpendicular to the local ellipsoid	m/s	Epoch
ICON_L27_Unit_Vector_X_East	Unit Vector X East Direction cosine transforming the instrument x-axis to the local east direction		Epoch
ICON_L27_Unit_Vector_X_North	Unit Vector X North Direction cosine transforming the instrument x-axis to the local east direction		Epoch
ICON_L27_Unit_Vector_X_Up	Unit Vector X Up Direction cosine transforming the instrument x-axis to the local vertical direction perpendicular to the local ellipsoid		Epoch
ICON_L27_Unit_Vector_Y_East	Unit Vector Y East Direction cosine transforming the instrument y-axis to the local east direction		Epoch
ICON_L27_Unit_Vector_Y_North	Unit Vector Y North Direction cosine transforming the instrument y-axis to the local east direction		Epoch
ICON_L27_Unit_Vector_Y_Up	Unit Vector Y Up Direction cosine transforming the instrument y-axis to the local vertical direction perpendicular to the local ellipsoid		Epoch
ICON_L27_Unit_Vector_Z_East	Unit Vector Z East Direction cosine transforming the instrument z-axis to the local east direction		Epoch

Variable Name	Description	Units	Dimensions
ICON_L27_Unit_Vector_Z_North	Unit Vector Z North Direction cosine transforming the instrument z-axis to the local east direction		Epoch
ICON_L27_Unit_Vector_Z_Up	Unit Vector Z Up Direction cosine transforming the instrument z-axis to the local vertical direction perpendicular to the local ellipsoid		Epoch
ICON_L27_Footpoint_East_Ion_Velocity_South	South Footpoint Ion Velocity East Velocity along local geodetic east direction, field-line mapped to southern footpoint. Velocity obtained using ion velocities relative to co-rotation in the instrument frame along with the corresponding unit vector transforming to ENU coordinates. Field-line mapping and the assumption of equi-potential field lines is used to translate the locally measured ion motion to the magnetic footpoint. The mapping is used to determine the change in magnetic field line distance, which, under assumption of equipotential field lines, in turn alters the electric field at that location (E=V/d).	m/s	Epoch
ICON_L27_Footpoint_North_Ion_Velocity_South	South Footpoint Ion Velocity North Velocity along local geodetic north direction, field-line mapped to southern footpoint. Velocity obtained using ion velocities relative to co-rotation in the instrument frame along with the corresponding unit vector transforming to ENU coordinates. Field-line mapping and the assumption of equi-potential field lines is used to translate the locally measured ion motion to the magnetic footpoint. The mapping is used to determine the change in magnetic field line distance, which, under assumption of equipotential field lines, in turn alters the electric field at that location (E=V/d).	m/s	Epoch
ICON_L27_Footpoint_Up_Ion_Velocity_South	South Footpoint Ion Velocity Up Velocity perpendicular to the local ellipsoid, field-line mapped to southern footpoint. Velocity obtained using ion velocities relative to co-rotation in the instrument frame along with the corresponding unit vector transforming to ENU coordinates. Field-line mapping and the assumption of equi-potential field lines is used to translate the locally measured ion motion to the magnetic footpoint. The mapping is used to determine the change in magnetic field line distance, which, under assumption of equipotential field lines, in turn alters the electric field at that location (E=V/d).	m/s	Epoch
ICON_L27_Footpoint_East_Ion_Velocity_North	North Footpoint Ion Velocity East Velocity along local geodetic east direction, field-line mapped to northern footpoint. Velocity obtained using ion velocities relative to co-rotation in the instrument frame along with the corresponding unit vector transforming to ENU coordinates. Field-line mapping and the assumption of equi-potential field lines is used to translate the locally measured ion motion to the magnetic footpoint. The mapping is used to determine the change in magnetic field line distance, which, under assumption of equipotential field lines, in turn alters the electric field at that location (E=V/d).	m/s	Epoch

Variable Name	Description	Units	Dimensions
ICON_L27_Footpoint_North_Ion_Velocity_North	South Footpoint Ion Velocity North Velocity along local geodetic north direction, field-line mapped to northern footpoint. Velocity obtained using ion velocities relative to co-rotation in the instrument frame along with the corresponding unit vector transforming to ENU coordinates. Field-line mapping and the assumption of equi-potential field lines is used to translate the locally measured ion motion to the magnetic footpoint. The mapping is used to determine the change in magnetic field line distance, which, under assumption of equipotential field lines, in turn alters the electric field at that location (E=V/d).	m/s	Epoch
ICON_L27_Footpoint_Up_Ion_Velocity_North	South Footpoint Ion Velocity Up Velocity perpendicular to the local ellipsoid, field-line mapped to northern footpoint. Velocity obtained using ion velocities relative to co-rotation in the instrument frame along with the corresponding unit vector transforming to ENU coordinates. Field-line mapping and the assumption of equi-potential field lines is used to translate the locally measured ion motion to the magnetic footpoint. The mapping is used to determine the change in magnetic field line distance, which, under assumption of equipotential field lines, in turn alters the electric field at that location (E=V/d).	m/s	Epoch
ICON_L27_Ion_Velocity_X_Error	Ion Velocity X Error Determined by adding in quadrature the velocity errors from instrument calibration, least-squares fitting and offset derivation.		Epoch
ICON_L27_Ion_Velocity_Y_Error	Ion Velocity Y Error Determined by adding in quadrature the velocity errors from instrument calibration and offset derivation.		Epoch
ICON_L27_Ion_Velocity_Z_Error	Ion Velocity Z Error Determined by adding in quadrature the velocity errors from instrument calibration and offset derivation.		Epoch
ICON_L27_Ion_Temperature_Error	Ion Temperature Error Obtained from residuals in least-squares fitting including calibration uncertainties		Epoch
ICON_L27_Fractional_Ion_Density_Error	Fractional Ion Density Error Determined from residuals in least squares fit of RPA currents to the Whipple equation		Epoch
ICON_L27_IVM_Aperture_Potential_Error	IVM Aperture Potential Error Derived directly from fit uncertainty when fitting is accomplished, ICON_L27_RPA_Flag_Process=0 . Derived from uncertainty in potential model when model is used, ICON_L27_RPA_Flag_Process=1		Epoch

Variable Name	Description	Units	Dimensions
ICON_L27_Ion_Velocity_Meridional_Error	Ion Velocity Meridional Error Determined by adding in quadrature the velocity errors in the instrument frame rotated into the magnetic field-meridional directionDetermined by adding in quadrature the velocity errors in the instrument frame rotated into the magnetic field-meridional direction		Epoch
ICON_L27_Ion_Velocity_Zonal_Error	Ion Velocity Zonal Error Determined by adding in quadrature the velocity errors in the instrument frame rotated into the magnetic field-meridional direction		Epoch
ICON_L27_Ion_Velocity_Field_Aligned_Error	Ion Velocity Field Aligned Error Determined by adding in quadrature the velocity errors in the instrument frame rotated into the magnetic field-aligned direction		Epoch
ICON_L27_Ion_Velocity_North_Error	Ion Velocity North Error Determined by adding in quadrature the velocity errors in the instrument frame rotated into the local geodetic north direction		Epoch
ICON_L27_Ion_Velocity_East_Error	Ion Velocity East Error Determined by adding in quadrature the velocity errors in the instrument frame rotated into the local geodetic east direction		Epoch
ICON_L27_Ion_Velocity_Up_Error	Ion Velocity Up Error Determined by adding in quadrature the velocity errors in the instrument frame rotated into the direction perpendicular to the local ellipsoid		Epoch

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

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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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