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 a preliminary 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. Current work on the data processing is driven by the generally low ionospheric densities resulting from low solar activity. During daytime hours, particularly mid-morning and later, all parameters are generally available and high quality. Good data for all parameters, including ion drifts, may be down-selected by selecting times where two flags,ICON_L27_RPA_FLAG and ICON_L27_DM_FLAG, are both zero. These flags are set conservatively and may be expanded in future releases. 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 the co-rotation velocity. 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=1). 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=1. 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=3). The low O+ densities exacerbates the impact of photoemission upon measurements within the DM. A first-order model has been developed and work is progressing on producing high-quality outputs during these periods. In the interim, ion drifts that require a significant photoemission correction have been masked (ICON_L27_DM_FLAG=2). Any spacecraft operations that may have the potential to impact the outputs are currently flagged (ICON_L27_RPA_FLAG=2, ICON_L27_DM_FLAG=1). Impacts are likely more prevalent in the DM than RPA, depending upon the operation. See spacecraft flags for more.

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.

Dimensions

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	86400

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 s/c 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 s/c position (geodetic) Geodetic Latitude of Spacecraft in WGS84	degrees North	Epoch
ICON_L27_Solar_Local_Time	Local Solar Time Local Solar Time at s/c	hour	Epoch
ICON_L27_Magnetic_Local_Time	Magnetic Local Time at s/c Magnetic Local Time at s/c.	hour	Epoch
ICON_L27_Longitude	WGS84 Longitude of s/c 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	Field-Aligned Ion Velocity 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 express the observed vector along a geomagnetic basis.	m/s	Epoch
ICON_L27_Ion_Velocity_Meridional	Meridional Ion Velocity 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 express the observed vector along a geomagnetic basis.	m/s	Epoch
ICON_L27_Ion_Velocity_X	Ion velocity along IVM-x Cross-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.	m/s	Epoch
ICON_L27_Ion_Velocity_Y	Ion velocity along IVM-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.	m/s	Epoch
ICON_L27_Ion_Velocity_Z	Ion velocity along IVM-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.	m/s	Epoch

Variable Name	Description	Units	Dimensions
ICON_L27_Ion_Velocity_Zonal	Zonal ion velocity 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 express the observed vector along a geomagnetic basis.	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_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

Variable Name	Description	Units	Dimensions
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
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

Variable Name	Description	Units	Dimensions
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	MTB Firing Status If the MTB are active during any part of the measurement, it is recorded as active for whole measurement. Decoded from s/c housekeeping file: /disks/icondata/Temporary/ICON.SDC.Pipeline.IVM.Ancillary.2020-04-29T171243.9A5B6086-0A2A-4A21-95A8-0B536FD075E3/Input/ICON_L0_Spacecraft_Housekeeping-MTB_2020-01-01_v01r001.CSV If the MTB are active during any part of the measurement, it is recorded as active for whole measurement. Decoded from s/c housekeeping file: If the MTB are active during any part of the measurement, it is recorded as active for whole measurement. Decoded from s/c housekeeping file: If the MTB are active during any part of the measurement, it is recorded as active for whole measurement. Decoded from s/c housekeeping file:	binary	Epoch
ICON_L27_Slew_Status			Epoch
ICON_L27_Sun_Status	s/c Sun/Shadow Status Code Data is from predictive ephemeris. 0=Sun, 1=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. Binary Coded Integer from Technical Note ICN-TN-027. 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 Standarized for several missions, so not all codes are relevant. Binary Coded Integer (16 bits). LVLH Normal Mode: 1, LVLH Reverse Mode: 2, Earth Limb Pointing: 4, Inertial Pointing: 8, Stellar Pointing: 16, Attitude Slew: 32, Conjugate Maneuver: 64, Nadir Calibration: 128, Lunar Calibration: 256, Stellar Calibration: 512	binary	Epoch
ICON_L27_Orbit_Number	Orbit Number Integer Orbit Number defined in ephemeris definition document.	integer	Epoch
ICON_L27_Magnetic_Latitude	Magnetic Latitude of s/c position Quasi-dipole magnetic latitude for S/C position	degrees North	Epoch
ICON_L27_Magnetic_Longitude	Magnetic Longitude of s/c position Quasi-dipole magnetic longitude for S/C position	degrees East	Epoch
ICON_L27_DM_Flag	Drift meter quality flag. 0 - Good data. 1 - Data may have artifacts due to s/c operations. 2 - Data temporarily removed for photoemission. 3 - Not enough O+ to measure arrival angle.		Epoch
ICON_L27_RPA_Flag	RPA Quality Flag Status flag for RPA. 0 - All RPA parameters are good. Ion temperatures correspond to both O+ and H+. 1 - Ram Ion Velocities are not good. Other parameters good. Plasma is presumed to be co-rotating when fitting RPA curves that have an insufficient quantity of O+. Ion temperatures correspond to H+ only. 2 - Geophysical outputs may be impacted by spacecraft operations.		Epoch

Variable Name	Description	Units	Dimensions
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
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 for S/C position	km	Epoch

Variable Name	Description	Units	Dimensions
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
ICON_L27_A_Status	IVM-A Status Binary Coded Integer from Technical Note ICN-TN-027. 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	binary	Epoch
ICON_L27_B_Status	IVM-B Status Binary Coded Integer from Technical Note ICN-TN-027. 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	binary	Epoch
ICON_L27_A_Activity	IVM-A ACTIVITY Binary Coded Integer from Technical Note ICN-TN-027. 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	binary	Epoch
ICON_L27_B_Activity	IVM-A ACTIVITY Binary Coded Integer from Technical Note ICN-TN-027. 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	binary	Epoch

Variable Name	Description	Units	Dimensions
ICON_L27_Footpoint_Altitude_North	Altitude of North Footpoint of Geomagnetic line at 150 km from IGRF Altitude location of the magnetic footpoint in Northern Hemisphere at 150 km. These data were interpolated using tricubic algorithm from IGRF and ephemeris data then linearly interploted to IVM times. These values should all be 150 km	km	Epoch
ICON_L27_Footpoint_Field_Aligned_Vector_ECEF_X_North	ECEF X-Conponent of field aligned drift at Northern Footpoint At the northern footpoint this is the x-conponent of the unit vector for field aligned ion drifts expressed in the ECEF frame.	dimensionless	Epoch
ICON_L27_Footpoint_Field_Aligned_Vector_ECEF_Y_North	ECEF Y-Conponent of field aligned drift at Northern Footpoint At the northern footpoint this is the y-conponent 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-Conponent of field aligned drift at Northern Footpoint At the northern footpoint this is the z-conponent 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 Northern Hemisphere at 150 km. These data were interpolated using 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 Northern Hemisphere at 150 km. These data were interpolated using 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

Variable Name	Description	Units	Dimensions
ICON_L27_Footpoint_Magnetic_Latitude_North	Quesi dipole latitude of northern footpoint Calculated value of quesi dipole latitude of northern footpoint from IGRF	degrees	Epoch
ICON_L27_Footpoint_Magnetic_Longitude_North	Quesi dipole longitude of northern footpoint Calculated value of quesi dipole longitude of northern footpoint from IGRF	degrees	Epoch
ICON_L27_Footpoint_Meridional_Vector_ECEF_X_North	ECEF X-Conponent of meridional drift at Northern Footpoint At the northern footpoint this is the x-conponent of the unit vector for meridional ion drifts expressed in the ECEF frame.	dimensionless	Epoch
ICON_L27_Footpoint_Meridional_Vector_ECEF_Y_North	ECEF Y-Conponent of meridional drift at Northern Footpoint At the northern footpoint this is the y-conponent 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-Conponent of meridional drift at Northern Footpoint At the northern footpoint this is the z-conponent 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-Conponent of Zonal drift at Northern Footpoint At the northern footpoint this is the x-conponent 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-Conponent of Zonal drift 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-Conponent of Zonal drift at Northern Footpoint At the northern footpoint this is the z-conponent of the unit vector for zonal ion drifts expressed in the ECEF frame.	dimensionless	Epoch

Variable Name	Description	Units	Dimensions
ICON_L27_Footpoint_Altitude_South	Altitude of South Footpoint of Geomagnetic line at 150 km from IGRF Altitude location of the magnetic footpoint in Northern Hemisphere at 150 km. These data were interpolated using tricubic algorithm from IGRF and ephemeris data then linearly interploted to IVM times. These values should all be 150 km	km	Epoch
ICON_L27_Footpoint_Field_Aligned_Vector_ECEF_X_South	ECEF X-Conponent of field aligned drift at Southern Footpoint At the Southern footpoint this is the y-conponent of the unit vector for field aligned ion drifts expressed in the ECEF frame.	dimensionless	Epoch
ICON_L27_Footpoint_Field_Aligned_Vector_ECEF_Y_South	ECEF Y-Conponent of field aligned drift at Southern Footpoint At the Southern footpoint this is the y-conponent 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-Conponent of field aligned drift at Southern Footpoint At the Southern footpoint this is the z-conponent 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 Southern Hemisphere at 150 km. These data were interpolated using 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 Southern Hemisphere at 150 km. These data were interpolated using 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

Variable Name	Description	Units	Dimensions
ICON_L27_Footpoint_Magnetic_Latitude_South	Quesi dipole latitude of southern footpoint Calculated value of quesi dipole latitude of southern footpoint from IGRF	degrees	Epoch
ICON_L27_Footpoint_Magnetic_Longitude_South	Quesi dipole longitude of southern footpoint Calculated value of quesi dipole longitude of southern footpoint from IGRF	degrees	Epoch
ICON_L27_Footpoint_Meridional_Vector_ECEF_X_South	ECEF X-Conponent of meridional drift at Southern Footpoint At the Southern footpoint this is the y-conponent of the unit vector for meridional ion drifts expressed in the ECEF frame.	dimensionless	Epoch
ICON_L27_Footpoint_Meridional_Vector_ECEF_Y_South	ECEF Y-Conponent of meridional drift at Southern Footpoint At the Southern footpoint this is the y-conponent 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-Conponent of meridional drift at Southern Footpoint At the Southern footpoint this is the z-conponent 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-Conponent of Zonal drift at Southern Footpoint At the Southern footpoint this is the x-conponent 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-Conponent of Zonal drift at Southern Footpoint At the Southern footpoint this is the y-conponent 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-Conponent of Zonal drift at Southern Footpoint At the Southern footpoint this is the z-conponent of the unit vector for zonal ion drifts expressed in the ECEF frame.	dimensionless	Epoch

Variable Name	Description	Units	Dimensions
ICON_L27_Observatory_Magnetic_Field_X	X Component of the Magnetic Field at s/c Magnetic field from IGRF at S/C position, expressed in the ECEF frame. x - component. (nT)	nT	Epoch
ICON_L27_Observatory_Magnetic_Field_Y	Y Component of the Magnetic Field Magnetic field from IGRF at S/C position, expressed in the ECEF frame. y - component. (nT)	nT	Epoch
ICON_L27_Observatory_Magnetic_Field_Z	Z Component of the Magnetic Field Magnetic field from IGRF at S/C position, expressed in the ECEF frame. z - component. (nT)	nT	Epoch
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. Array is set up as [(X,Y,Z),Epoch]	m/s	Epoch
ICON_L27_Observatory_Velocity_Y	ECI Spacecraft Velocity Velocity of spacecraft in ECI, J2000, cooridinates. Array is set up as [(X,Y,Z),Epoch]	m/s	Epoch

Variable Name	Description	Units	Dimensions
ICON_L27_Observatory_Velocity_Z	ECI Spacecraft Velocity Velocity of spacecraft in ECI, J2000, cooridinates. Array is set up as [(X,Y,Z),Epoch]	m/s	Epoch
ICON_L27_Observatory_Corotation_X	ECI Earth Corotation Velocity Components in IVM Coordinates Component of Earth's corotation velocity in the IVM instrament axes. [(X,Y,Z),Epoch]	m/s	Epoch
ICON_L27_Observatory_Corotation_Y	ECI Earth Corotation Velocity Components in IVM Coordinates Component of Earth's corotation velocity in the IVM instrament axes. [(X,Y,Z),Epoch]	m/s	Epoch
ICON_L27_Observatory_Corotation_Z	ECI Earth Corotation Velocity Components in IVM Coordinates Component of Earth's corotation velocity in the IVM instrament axes. [(X,Y,Z),Epoch]	m/s	Epoch
ICON_L27_Solar_Zenith_Angle	Solar Zenith Angle Solar Zenith Angle of s/c.	degrees	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. Guidelines for the use of this product are described in the ICON Rules of the Road (https://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

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.
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.

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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